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# (54) A FUEL INJECTOR FOR A LARGE TWO-STROKE INTERNAL COMBUSTION ENGINE

KRAFTSTOFFEINSPRITZVENTIL FÜR EINE GROSSE ZWEITAKTBRENNKRAFTMASCHINE

INJECTEUR DE CARBURANT POUR MOTEUR A EXPLOSION A DEUX TEMPS DE GRANDES DIMENSIONS

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## Description

The invention relates to a fuel injector for a large two-stroke internal combustion engine, such as a diesel engine for propulsion of a ship, having an elongated outer housing for mounting in a water-cooled cylinder cover in such a manner that the valve has an upper cooled valve section and a lower substantially uncooled valve section comprising at least the lower part of the fuel nozzle with transverse nozzle holes extending from a central longitudinal nozzle bore, and wherein a valve slide has an upper section carrying a movable valve part for a primary valve seat positioned in the cooled valve section and intended for opening and closing for the fuel injection, and a thin lower section extending down into the nozzle bore and carrying a secondary closing member for the fuel flow to the nozzle holes and positioned in the lower valve section.

Fuel injectors for four-stroke engines are known in which the primary valve seat is positioned directly above the nozzle holes, *vide,* for example, EP-A-0 451 408. The front part of the injector with the valve seat is here cooled by the cooling water in the cylinder cover, because the latter has such a small thickness and the injector housing is so short that the cooling has effect all the way down to the tip of the injector. As a result of the cooling, the nozzle and the valve seat may be made of tempered steel.

In large two-stroke engines, the cylinder cover is so thick that the lower valve section of the injector extends so far from the abutment surface of the injector against the cooling cylinder cover downwards to the nozzle bores that the lower section becomes substantially uncooled and becomes heated to a high temperature by the combustion gases of the engine. Compared to medium and high-speed engines fuelled by diesel oil, the temperature level is further increased in the large two-stroke internal combustion engines that are fuelled by heavy fuel oil pre-heated to a temperature of approximately 150°C. It is a well known fact by injectors in these engines that the temperature level in the protruding portion of the fuel nozzle may attain 500 to 600°C. As the high temperatures in the lower valve section will lead to functional failures in a primary valve seat, for example owing to coking or erosion of material, the primary valve seat in these injectors should be positioned in the upper, cooled valve section. The result is that the flow passage between the primary valve seat and the nozzle holes becomes long and has a large volume, which is typically in the order of from 2 to 3 per cent of the fuel volume injected during an engine cycle.

When the primary valve seat closes at the end of the fuel injection, the fuel amount in the passage between the valve seat and the nozzle holes is cut off from the feed pressure of the fuel. This amount of fuel can seep or drip out through the nozzle bores in the period when the injector is basically closed. As this residual amount of fuel is not atomized into the combustion chamber, only little or no combustion of the fuel is obtained. The unburnt fuel leads to coking of the combustion chamber and of the downstream engine components and to an environmentally unfortunate emission of fuel with the exhaust gas, and naturally also to an increased fuel consumption.

Most of these disadvantages have been remedied by the fuel injector described in WO 93/07386, which is of the type mentioned in the introduction. The valve slide here carries a secondary closing member in the shape of a ring which, in the closed position of the injector, extends down past the nozzle holes and cuts them off, so that the amount of oil in the passage below the primary valve seat is prevented from flowing out through the nozzle holes when the injector is closed. At the opening movement of the injector, the ring slides upwards in the nozzle bore so that the nozzle holes are uncovered. The central nozzle bore has a constant diameter to permit insertion and displacement of the sliding ring in the bore.

In practice, the injector with a secondary closing member has proved to involve a higher fuel consumption, particularly at heavy engine loads. This is presumably due to changed injection conditions when the injector is open and the oil is atomized into the combustion chamber.

The object of the invention is to provide a fuel injector which, despite a relatively high temperature level in the area around the nozzle holes, is able both to restrict the emission of fuel when the injector is closed, and to provide an advantageously good injection and distribution of the fuel when the injector is open.

With a view to this object, the fuel injector according to the invention is characterized in that the nozzle bore has an area with a downwards diminishing diameter located in the lower valve section, that the nozzle holes extend from the bore section with a smaller diameter, that the lower section of the valve slide ends at a level above the uppermost nozzle hole, and that the secondary closing member is positioned at the area for the diminishing diameter of the bore when the slide is in its closing position.

It has surprisingly turned out that the fuel injector according to the invention fulfils the above object. The secondary closing member prevents the upstream amount of fuel in penetrating to the nozzle holes when the injector is closed. An explanation of the reduced fuel consumption when the injector is open may presumably be found in the fact that the bore section leading to the nozzle holes has an advantageously small diameter, which provides uniform flow conditions to the nozzle holes. As the valve slide in all positions ends at a level above the nozzle holes, the fuel flow to these holes is presumably only slightly affected by the presence of a secondary closing member.

In the closed position of the valve, the primary valve seat prevents the fuel pressure on the pump side from influencing the area around the secondary closing member. There is thus no appreciable pressure drop across the closing member, which involves freedom to design it in a manner so that in its closed position, the closing member only influences the material of the fuel nozzle with extremely small forces.

The termination of the valve slide at a distance from the upper nozzle hole also yields the advantage that the slide tip is not influenced by the erosion forces occurring around the nozzle holes when the valve opens.

In a preferred embodiment, the secondary closing member has a cylindrical section which may slide sealingly into the section with a smaller diameter of the nozzle bore. When the slide is moved downwards towards the closing position, the cylindrical section is displaced into the narrower lower section of the nozzle bore so that the flow connection between the nozzle holes and the broader upstream section of the nozzle bore is interrupted. The cylindrical section only affects the nozzle itself with the small frictional force which occurs when the surfaces slide past each other. In the closed position of the injector, the cylindrical section is received inside the lower section of the nozzle bore without the nozzle being affected by closing forces proper.

In an embodiment which is particularly simple to manufacture, the thin lower section of the valve slide with the secondary closing member is a rigid extension of the upper section of the slide. The rigidity of the thin section causes the slide tip to be kept coaxial with the upper section of the slide and thus also coaxial with the nozzle bore.

In an alternative embodiment, the thin lower section of the valve slide is a transversely flexible extension of its upper section, and at a level above the secondary closing member, the lower section has a guide which centres the closing member in the nozzle bore by abutment against the wall of the section of the bore with a larger diameter. The separate guide for centring the slide tip is, of course, more difficult to manufacture than a cylindrical, smooth lower section, but in return there is no need for the lower section of the slide to be aligned with the upper section, as the tip of the slide is self-centring in the nozzle bore. This substantially facilitates the mounting of the slide in the injector and ensures good centring of the slide tip even after long-term operation. The self-aligning slide tip is especially advantageous in the cases where the lower section of the slide is a separate replaceable unit.

Preferably, the guide is designed as several radially extending longitudinal fins on the lower section of the slide, and the upper and lower ends of the fins are preferably pointed. The longitudinal fins only slightly disturb the downward flow of fuel when the injector is open. The flow disturbances can be further diminished by making the ends of the fins pointed so that the flow achieves a smooth runoff from the fins. In consideration of the best possible flow conditions in the lower section of the nozzle, the lower free end of the slide may suitably be conical so that not too many eddies are started in the fuel when it changes at the passage of the secondary closing member from flowing around the slide to itself filling out the whole of the cross-section of the bore.

Particularly if the fuel is gaseous, it may be suitable to design the injector so that the secondary closing member in its closed position abuts an inclined surface in the area of the bore with a diminishing diameter, and that said closing member is displaceable in the longitudinal direction of the slide and spring-loaded for movement away from the upper section of the slide. The inclined surface acts as a valve seat, but as a result of the displaceability of the secondary closing member in relation to the upper section of the slide, the closing member cannot be pressed against the seat with more than the force produced by the associated spring. The spring force may be adapted to the strength of the material in the nozzle, that is, the spring force may, for example, be chosen to be so small that the closing member largely puts no load on the seat material.

Preferably, the lower thin section of the valve slide with the secondary closing member is a separate unit, which is removably fastened to the upper section. This renders it possible to replace the secondary closing member independently of the upper section of the slide, and furthermore an advantage in manufacturing is obtained in that the two sections can be manufactured separately, that is, also in individual materials, if it is desired that the closing member is of a more temperature-resistant material than the upper section of the slide.

To obtain the largest possible limitation of the oil loss in periods when the injector is closed, the area of the nozzle bore with a diminishing diameter is preferably substantially closer to the nozzle holes than to the primary valve seat. This limits the volume of the nozzle bores below the secondary closing member.

To achieve a good initiation of the atomizing of the fuel when the injector is opened, the latter may suitably be designed so that the secondary closing member only opens the section of the nozzle bore with a smaller diameter when the movable valve part of the slide has been moved a predetermined distance away from the primary valve seat. Thus, the pressure of the fuel in the section of the nozzle bore with a larger diameter may be raised to a suitably high pressure, before the closing member opens for the passage of fuel to the bore leading to the nozzle holes. When the fuel starts being ejected through the nozzle holes, this therefore occurs at a higher pressure, which promotes the atomization. The delay in the opening of the closing member can be adjusted in one embodiment via the length of the cylindrical section which can slide sealingly into the nozzle bore, and in another embodiment, the delay is adjusted by means of the position of a stop which pulls a displaceable closing member along in the movement of the slide.

Examples of embodiments of the invention will now be described in further detail below with reference to the schematic drawing, in which

Fig. 1 is a view of a longitudinal section through a first embodiment of a fuel injector,

Figs. 2 and 3, in a larger scale, are views of the lower section of a second embodiment of an injector in its open and closed positions, respectively,

Figs. 4 and 5 are corresponding views of a third embodiment mounted in a cylinder cover, and

Figs. 6 and 7 are corresponding views of a fourth embodiment.

Fig. 1 shows a fuel injector or fuel valve generally designated 1 with an upper flange 2 for fastening the injector in the engine. The flange has an upward connecting piece 3 to which may be fastened a pressure pipe, not shown, which feeds pressurized fuel from a suitable source, such as a fuel pump or a high-pressure reservoir.

At its lower end the injector has a nozzle 4. The fuel may be passed from the connection at the connecting piece 3 down towards the nozzle 4 through an upper flow passage 5, which passes from a central bore 6 in the connecting piece through a spring guide 7 and a circulation slide 8 down to a pressure chamber 9 delimited by the slide 8 and a guide 10 for the latter. At the lower side of a seat 11, the fuel may flow further down towards the nozzle through a middle flow passage 12 in the form of a central bore in a pressure pipe 13, a pressure piece 14 and a valve slide 15, in which the central bore is connected with a primary pressure chamber 16 through several inclined bores 17. The middle flow passage ends downwards at a primary valve seat 18. Below this valve seat, in the open position of the injector, the fuel may flow onwards through a lower flow passage 19 in the form of a central bore 20 (*vide* Fig. 2) at the bottom of a slide guide 21 for the valve slide 15 and a nozzle bore coaxial therewith.

The central longitudinal nozzle bore comprises an upper bore section 22 with a larger diameter, which merges through an area 23 with a diminishing diameter into a lower bore section with a smaller diameter, from which nozzle holes 24 extend as shown in the subsequent figures.

When the injector is in its closed position shown in Fig. 1, the upper flow passage 5 is connected via a transverse passage, not shown, in the spring guide 7 with the cavity surrounding the spring guide so that pre-heated fuel can circulate in the upper part of the injector in a well-known manner. It may be noted here that the injector in Fig. 1 is intended for the injection of oil, particularly heavy fuel oil. When the fuel injection is to be initiated, the oil pressure in the upper flow passage 5 and in the pressure chamber 9 increases so that the circulation slide 8 is moved upwards and cuts off the transverse circulation passage. At the same time, the flow passage past the seat 11 opens, and the pressure spreads down through the middle flow passage 12 and the inclined bores 17 to the primary pressure chamber 16. A compression spring 25 bears on an upper spring disc 26 and presses downwards via a lower spring disc 27 on the valve slide 15, so that a valve part 28 which is in the shape of an annular conical surface on the valve slide and is movable in relation to the primary valve seat 18, is pressed sealingly against the valve seat 18.

When the oil pressure in the primary pressure chamber 16 reaches the valve opening pressure determined by the pre-loading of the compression spring 25, the valve slide 15 is moved upwards, and at the same time the oil begins to flow past the primary valve seat 18.

The movable valve part 28 delimits the upper section of the valve slide 15 from a thin lower section 30 of the slide. In the embodiment shown in Fig. 1, the lower section 30 is cylindrical and has a diameter which is slightly smaller than the diameter of the section 29 of the nozzle bore with smaller diameter, so that the lower section 30 of the slide can slide sealingly into the lower bore section 29. As the lower section 30 projects a distance into the bore section 29 when the injector is closed, the pressure is built up by opening of the valve in the upper bore section 22, before the lower section 30 of the slide is lifted out of the bore section 29, whereby an opening is made for the oil flow to the nozzle holes. The pressure build-up in the oil before the final passage to the nozzle holes promotes the fine atomization of the oil at the initiation of the atomization.

The nozzle holes not shown in Fig. 1 are positioned at the end of the bore section 29, that is, several bore diameters away from the lower conical tip of the valve slide 15 when the slide is in its closed position as shown. The lower section 30 of the valve slide has a substantially constant diameter, but only needs accurate machining on the lowest portion, which acts as a closing member 32 and slides into the lower section 29 of the nozzle bore.

In the first embodiment shown in Fig. 1, the lower section 30 of the valve slide 15 is formed integrally with the upper section of the valve slide and as a rigid extension thereof, whereby, without any further guidance than the positioning of the upper slide section in the slide guide 21, the lower section 30 is centred in relation to the nozzle bore.

In the mounted position of the injector, an abutment surface 31 at the front end of the injector housing 2a is clamped down against a conical surface facing upwards on the cylinder cover of the engine. This abutment surface is the lowest place where the injector is exposed to a substantial cooling effect, which occurs because the cover is cooled by a coolant circulating in the engine and keeping the cover temperature at the abutment surface 31 at, for example, 80°C. Above the conical abutment surface 31, the temperature of the injector corresponds largely to the temperature of the oil which circulates in the injector and may be preheated to, for example, 120-150°C. In at least its lowest part, the nozzle section located below the inclined abutment surface 31 is in contact with the high temperatures in the combustion chamber of the cylinder. The lowest part of the nozzle is thus in practice uncooled. As a whole, then, the valve 1 may be said to be divided into an upper cooled valve section la positioned above the abutment surface 31 and a lower, substantially uncooled valve section 1b extending from the lower end of the nozzle 4 and up close to the abutment surface 31.

The nozzle 4 is of a high-temperature-resistant material which can also resist the erosion influences of the fuel in the area around the nozzle holes. As tempered steel is not able to withstand the high temperature level in the uncooled valve section 1b, the nozzle is manufactured from, for example, Stellite 6 or another high-temperature-resistant alloy, such as INCONEL ALLOY ma758 as described in EP-A-0 569 655.

It can be seen that the primary valve seat is positioned in the cooled valve section, while both the closing member 32 and the upper portion of the section 29 of the bore are positioned in the uncooled valve section 1b. As the closing member 32 largely does not influence the material of the nozzle with forces acting in the longitudinal direction, both the closing member and the nozzle have long lives despite the high temperature level.

In the following description of other embodiments, the same reference numerals as above are used for elements having the same function.

The second embodiment of the fuel injector shown in Figs. 2. and 3 is also intended for an engine using oil as fuel. The thin lower section 30 of the valve slide is here a separate replaceable unit which at its upper end has an external thread screwed up into an internal thread in a central bore 40 at the lower end of the upper section of the valve slide, until a collar 41 on the lower section 30 abuts the end surface of the upper section. A locking pin 45 inserted in aligned bores in the upper and lower sections of the slide locks the lower section 30 against rotation in relation to the upper section of the slide. If the lower slide section 30 gets worn or damaged, the locking pin 45 may be removed, and the lower section 30 may be replaced by a new one. This avoids replacement of the whole slide.

The lower section 30 is elongated, thin and flexible in the transverse direction seen in relation to the upper section of the valve slide. When the slide is in its closing position shown in Fig. 3, the closing member 32, formed by the front cylindrical portion of the section 30 projects down into the bore section 29 and prevents the oil in the upper bore section 22 from penetrating to the nozzle holes 24. The amount of oil in the bore section 29 below the tip of the valve slide amounts to about 10 per cent of the total amount of oil present below the primary valve seat 18.

The closing member 32 is centred in the nozzle bore by means of a guide 42, which slides along a guiding surface 43 in the nozzle bore. The guide 42 consists of several, for example four, radially extending, longitudinal fins, the upper and lower ends of which are pointed. The oil can flow past the guide 42 through the longitudinal spaces between the fins.

In Fig. 2, the valve slide 15 is shown in its fully open position, where the oil flows past the primary valve seat 18 and down into the nozzle bore, where the oil in the area 23 with a diminishing diameter flows past the conical free end 44 of the valve slide and flows on down to the nozzle holes 24 as a joint flow covering the full cross-section of the nozzle bore. The distance between the free end 44 of the slide and the nozzle holes is presumably so large that the oil flow down into the nozzle holes is substantially undisturbed by the fact that the lower section 30 of the slide extends far down into the nozzle bore.

The number of nozzle holes 24 at the tip of the nozzle depends on the power to be yielded by the working cylinder of the engine and of the number of injectors per cylinder. There may be, for example, four or five nozzle holes which all open out on the same side of the nozzle, so that the longitudinal axes of the two outermost nozzle holes form a mutual angle of not more than 100° and often only of 80° or less. The oil is thus atomized into a fan-shaped mist of finely distributed oil particles.

Now, injectors for injection of gaseous fuel will be described. In principle, the injectors are constructed in the same manner as described above except for the fact that the valve slide is lifted by means of control oil which influences a piston area adapted for the purpose on the slide, and that the gas is supplied sideways into the lower part of the valve housing through an inlet conduit 50 in the cover indicated by 51 and an oblique conduit 52 in the valve housing 33.

The oblique conduit 52 opens out into a pressure chamber 53 which is positioned directly above the primary valve seat 18. The construction and the mode of operation of such a gas injector is well-known in the art. The injector must inject a relatively large volume of gas during an engine cycle. The flow passages in the injector therefore must have a suitably large cross-sectional area, which means that the nozzle bore and thus also the nozzle itself have a large diameter. The injector abutment surface 31', which is pressed against a cooling conical surface on the cover 51, is therefore formed on the nozzle 4 itself so that the outer diameter of the injector housing may be kept suitably small. Otherwise it appears from Fig. 4 that near the surface 54 the cover has cooling channels 55. The portion of the nozzle positioned below the abutment surface 31' is affected by the very high temperature level in the combustion chamber 56 and is in practice uncooled.

As the gas is substantially more easy-flowing than oil, and the nozzle bores have a substantially larger diameter than in the above embodiments, it is most suitable that the closing member on the lower section 30 of the valve slide abuts a conical inclined surface 57 in the area of the bore with a diameter diminishing downwards. The closing member may be a valve needle 58, as shown in Figs. 4 and 5, or a ball-shaped valve member 59, as shown in Figs. 6 and 7.

The closing member is not pressed against the inclined surface 57 with a valve closing force of the same magnitude as the closing force acting on the primary valve seat 18, but is only biased towards a closed position by a weak compression spring. It may, for example, be a compression spring 61 which is received in a cavity in the upper section of the valve slide and presses on the whole lower slide section 30, which is displaceably positioned in a central bore in the upper section, or it may be a compression spring 60 (*vide* Figs. 6 and 7) which surrounds the lower slide section 30 and acts on the valve portion 59 which is longitudinally displaceably positioned on the lower section 30.

The displaceably positioned slide section 30 shown in Figs. 4 and 5 carries one part of a bayonet coupling, for example several projecting fins at its upper end. These fins may be passed up through corresponding grooves at the end of the upper section of the valve slide. When the fins have been passed into the cavity, the lower section may be turned to its mounted position where, by abutting the bottom of the cavity, the bottom side of the fins acts as a stop to the downward displacement of the section 30 in relation to the upper section of the valve slide.

The valve portion 59 shown in Figs. 6 and 7 is restricted in its displacement away from the upper section of the valve slide by a stop in the form of a collar 62 which catches a thickened lower portion of the slide section 30.

It is evident that elements from the various embodiments described can be combined in different ways into new embodiments.

In the embodiments shown on the drawings the secondary closing member is in its closing position positioned at level with the ceiling of the combustion chamber.

## Claims

1. A fuel injector (1) for a large two-stroke internal combustion engine, such as a diesel engine for propulsion of a ship, having an elongated outer housing (33) for mounting in a water-cooled cylinder cover (51) in such a manner that the valve (1) has an upper cooled valve section (1a) and a lower substantially uncooled valve section (1b) comprising at least the lower part of the fuel nozzle (4) with transverse nozzle holes (24) extending from a central longitudinal nozzle bore, and wherein a valve slide (15) has an upper section carrying a movable valve part (28) for a primary valve seat (18) positioned in the cooled valve section for opening and closing for the fuel injection, and a thin lower section (30) extending down into the nozzle bore (22, 23, 29) and carrying a secondary closing member for the fuel flow to the nozzle holes and positioned in the lower valve section, **characterized** in that the nozzle bore has an area (23) with a downwards diminishing diameter located in the lower valve section (1b), that the nozzle holes (24) extend from the bore section (29) with a smaller diameter, that the lower section (30) of the valve slide ends at a level above the upper nozzle hole, and that the secondary closing member (32; 58; 59) is positioned at the area (23) for the diminishing diameter of the bore when the slide (15) is in its closing position.

2. A fuel injector according to claim 1, **characterized** in that the secondary closing member (32) has a cylindrical portion which may slide sealingly into the section (29) of the nozzle bore with a smaller diameter.

3. A fuel injector according to claim 1 or 2, **characterized** in that the thin lower section (30) of the valve slide with the secondary closing member (32) is a rigid extension of the upper section.

4. A fuel injector according to claim 1 or 2, **characterized** in that the thin lower section (30) of the valve slide is a transversely flexible extension of its upper section, and that at a level above the secondary closing member (32), the lower section has a guide (42) which centres the closing member in the nozzle bore by abutment against the wall of the section (22) of the bore with a larger diameter.

5. A fuel injector according to claim 4, **characterized** in that the guide (42) has several radially extending longitudinal fins on the lower section (30) of the slide, and that the upper and lower ends of the fins are preferably pointed.

6. A fuel injector according to claim 1, **characterized** in that in its closed position, the secondary closing member (58; 59) abuts an inclined surface (57) in the area (23) of the bore with a diminishing diameter, and that said closing member is displaceable in the longitudinal direction of the slide and spring-loaded for movement away from the upper section of the slide (15).

7. A fuel injector according to any one of the preceding claims, **characterized** in that the lower thin section (30) of the valve slide with the secondary closing member (32; 58; 59) is a separate unit, which is removably fastened to the upper section.

8. A fuel injector according to any one of the preceding claims, **characterized** in that the area (23) of the nozzle bore with a diminishing diameter is preferably substantially closer to the nozzle holes (24) than to the primary valve seat (18).

9. A fuel injector according to any one of the preceding claims, **characterized** in that the secondary closing

member only opens the section (29) of the nozzle bore with a smaller diameter when the movable valve part (28) of the slide has been moved a predetermined distance away from the primary valve seat (18).

**10.** A fuel injector according to any one of the preceding claims, **characterized** in that the lower free end (44; 58) of the slide is conical.

## Patentansprüche

**1.** Kraftstoffeinspritzventil (1) für eine große Zweitaktbrennkraftmaschine, wie einen Dieselmotor zum Antrieb eines Schiffes, mit einem langgestreckten Außengehäuse (33) zur Befestigung in einem wassergekühlten Zylinderdeckel (51) in der Weise, daß das Ventil (1) einen oberen gekühlten Ventilbereich (1a) und einen unteren im wesentlichen ungekühlten Ventilbereich (1b) aufweist, der zumindest den unteren Teil der Kraftstoffdüse (4) mit Düsenquer-öffnungen (24) umfaßt, die von einer mittleren Düsenlängsbohrung ausgehen, und wobei ein Ventilschieber (15) einen oberen Bereich, der einen beweglichen Ventilteil (28) für einen primären Ventilsitz (18) im gekühlten Ventilbereich zum Öffnen und Schließen für die Kraftstoffeinspritzung trägt, und einen dünnen unteren Bereich (30) aufweist, der sich nach unten in die Düsenbohrung (22, 23, 29) erstreckt und ein sekundäres Schließglied für den Kraftstoffstrom zu den Düsenöffnungen trägt und im unteren Ventilbereich angeordnet ist, **dadurch gekennzeichnet,** daß die Düsenbohrung eine Zone (23) mit einem nach unten kleiner werdenden Durchmesser im unteren Ventilbereich (1b) aufweist, daß die Düsenöffnungen (24) von dem Bohrungsbereich (29) mit einem kleineren Durchmesser ausgehen, daß der untere Bereich (30) des Ventilschiebers auf einem Niveau oberhalb der oberen Düsenöffnung endet und daß das sekundäre Schließglied (32; 58; 59) in der Zone (23) für den kleiner werdenden Durchmesser der Bohrung angeordnet ist, wenn sich der Schieber (15) in seiner Schließstellung befindet.

**2.** Kraftstoffeinspritzventil nach Anspruch 1, dadurch gekennzeichnet, daß das sekundäre Schließglied (32) einen zylindrischen Teil aufweist, der mit Dichtungseingriff in den Bereich (29) der Düsenbohrung mit kleinerem Durchmesser hineingleiten kann.

**3.** Kraftstoffeinspritzventil nach Anspruch 1 oder 2, dadurch gekennzeichnet, daß der dünne untere Bereich (30) des Ventilschiebers mit dem sekundären Schließglied (32) eine starre Verlängerung des oberen Bereichs ist.

**4.** Kraftstoffeinspritzventil nach Anspruch 1 oder 2, dadurch gekennzeichnet, daß der dünne untere Bereich (30) des Ventilschiebers eine in Querrichtung flexible Verlängerung seines oberen Bereichs ist und daß auf einem Niveau oberhalb des sekundären Schließgliedes (32) der untere Bereich eine Führung (42) aufweist, die das Schließglied in der Düsenbohrung durch Anlage an der Wand des Bereichs (22) der Bohrung mit größerem Durchmesser zentriert.

**5.** Kraftstoffeinspritzventil nach Anspruch 4, dadurch gekennzeichnet, daß die Führung (42) mehrere sich in radialer Richtung erstreckende Längsrippen am unteren Bereich (30) des Schiebers aufweist und daß die oberen und unteren Enden der Rippen vorzugsweise zugespitzt sind.

**6.** Kraftstoffeinspritzventil nach Anspruch 1, dadurch gekennzeichnet, daß das sekundäre Schließglied (58; 59) in seiner geschlossenen Stellung an einer Schrägfläche (57) in der Zone (23) der Bohrung mit kleiner werdendem Durchmesser anliegt und daß das Schließglied in Längsrichtung des Schiebers verschieblich und für eine Fortbewegung vom oberen Bereich des Schiebers (15) federbeaufschlagt ist.

**7.** Kraftstoffeinspritzventil nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß der untere dünne Bereich (30) des Ventilschiebers mit dem sekundären Schließglied (32; 58; 59) eine gesonderte Einheit ist, die am oberen Bereich abnehmbar befestigt ist.

**8.** Kraftstoffeinspritzventil nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß die Zone (23) der Düsenbohrung mit kleiner werdendem Durchmesser vorzugsweise wesentlich näher an den Düsenöffnungen (24) als am primären Ventilsitz (18) liegt.

**9.** Kraftstoffeinspritzventil nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß das sekundäre Schließglied den Bereich (29) der Düsenbohrung mit kleinerem Durchmesser nur öffnet, wenn der bewegliche Ventilteil (28) des Schiebers um eine vorbestimmte Strecke vom primären Ventilsitz (18) wegbewegt worden ist.

**10.** Kraftstoffeinspritzventil nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß das untere freie Ende (44; 58) des Schiebers konisch ist.

## Revendications

1. Injecteur de carburant (1) pour moteur à explosion deux temps de grande taille, par exemple un moteur diesel pour propulsion d'un navire, comportant un boîtier externe allongé (33) pour montage dans un chapeau de cylindre (51) à refroidissement par eau, de telle manière que la soupape (1) présente une section supérieure refroidie de soupape (1a) et une section inférieure de soupape (1b), essentiellement non-refroidie, comprenant, au moins, la partie inférieure de l'ajutage de carburant (4) avec des orifices transversaux d'ajutage (24) s'étendant depuis un alésage central longitudinal d'ajutage, et où un tiroir (15) de soupape comporte une section supérieure portant une pièce mobile de soupape (28) pour un siège primaire de soupape (18), situé dans la section refroidie de soupape, pour ouvrir et fermer l'injection de carburant, et une section inférieure mince (30), qui s'étend vers le bas dans l'alésage d'ajutage (22, 23, 29) et qui, dans la section inférieure de soupape, porte une pièce secondaire de fermeture de l'écoulement de carburant aux orifices d'ajutage, **caractérisé** en ce que l'alésage d'ajutage présente une zone (23) dont le diamètre va en diminuant vers le bas et qui est située dans la section inférieure de soupape (1b), en ce que les orifices d'ajutage (24) s'étendent depuis la section d'ajutage (29) à diamètre réduit, en ce que la section inférieure (30) du tiroir de soupape se termine à un niveau situé au-dessus de l'orifice supérieur d'ajutage, et en ce que la pièce secondaire de fermeture (32; 58; 59) se trouve située dans la zone (23) de l'alésage, dont le diamètre va en diminuant, lorsque le tiroir (15) se trouve dans sa position de fermeture.

2. Injecteur de carburant selon la revendication 1, **caractérisé** en ce que la pièce secondaire de fermeture (32) présente une partie cylindrique qui, de façon étanche, peut glisser dans la section (29) de l'alésage d'ajutage à diamètre réduit.

3. Injecteur de carburant selon les revendications 1 ou 2, **caractérisé** en ce que la section inférieure mince (30) du tiroir de soupape avec la pièce secondaire de fermeture (32) forme un prolongement rigide de la section supérieure.

4. Injecteur de carburant selon les revendications 1 ou 2, **caractérisé** en ce la section inférieure mince (30) du tiroir de soupape est un prolongement transversalement flexible de sa section supérieure, et en ce qu'à un niveau au dessus de la pièce secondaire de fermeture (32), la section inférieure comporte un guide (42) qui centre la pièce de fermeture dans l'alésage d'ajutage par appui contre la paroi de la section (22) de l'alésage à diamètre plus grand.

5. Injecteur de carburant selon la revendication 4, **caractérisé** en ce que le guide (42) comporte plusieurs ailettes longitudinales, s'étendant radialement, sur la section inférieure (30) du tiroir, et en ce que les extrémités supérieure et inférieure des ailettes sont, de préférence, pointues.

6. Injecteur de carburant selon la revendication 1, **caractérisé** en ce que dans sa position fermée, la pièce secondaire de fermeture (58; 59) est en butée contre une surface inclinée (57) dans la zone (23) de l'alésage, dont le diamètre va en diminuant, et en ce que ladite pièce de fermeture est déplaçable dans le sens longitudinal du tiroir et chargée par ressort pour mouvement s'éloignant de la section supérieure du tiroir (15).

7. Injecteur de carburant selon l'une quelconque des revendications précédentes, **caractérisé** en ce que la section inférieure mince (30) du tiroir de soupape avec la pièce secondaire de fermeture (32; 58; 59) est un ensemble séparé, monté, de façon amovible, sur la section supérieure.

8. Injecteur de carburant selon l'une quelconque des revendications précédentes, **caractérisé** en ce que la zone (23) de l'alésage d'ajutage, dont le diamètre va en diminuant, se trouve, de préférence, essentiellement plus proche des orifices d'ajutage (24) que du siège primaire de soupape (18).

9. Injecteur de carburant selon l'une quelconque des revendications précédentes, **caractérisé** en ce que la pièce secondaire de fermeture n'ouvre la section (29) de l'alésage d'ajutage à diamètre réduit que lorsque la pièce mobile de soupape (28) du tiroir a été déplacée d'une distance prédéterminée depuis le siège primaire de soupape (18).

10. Injecteur de carburant selon l'une quelconque des revendications précédentes, **caractérisé** en ce que l'extrémité inférieure libre (44; 58) du tiroir est conique.

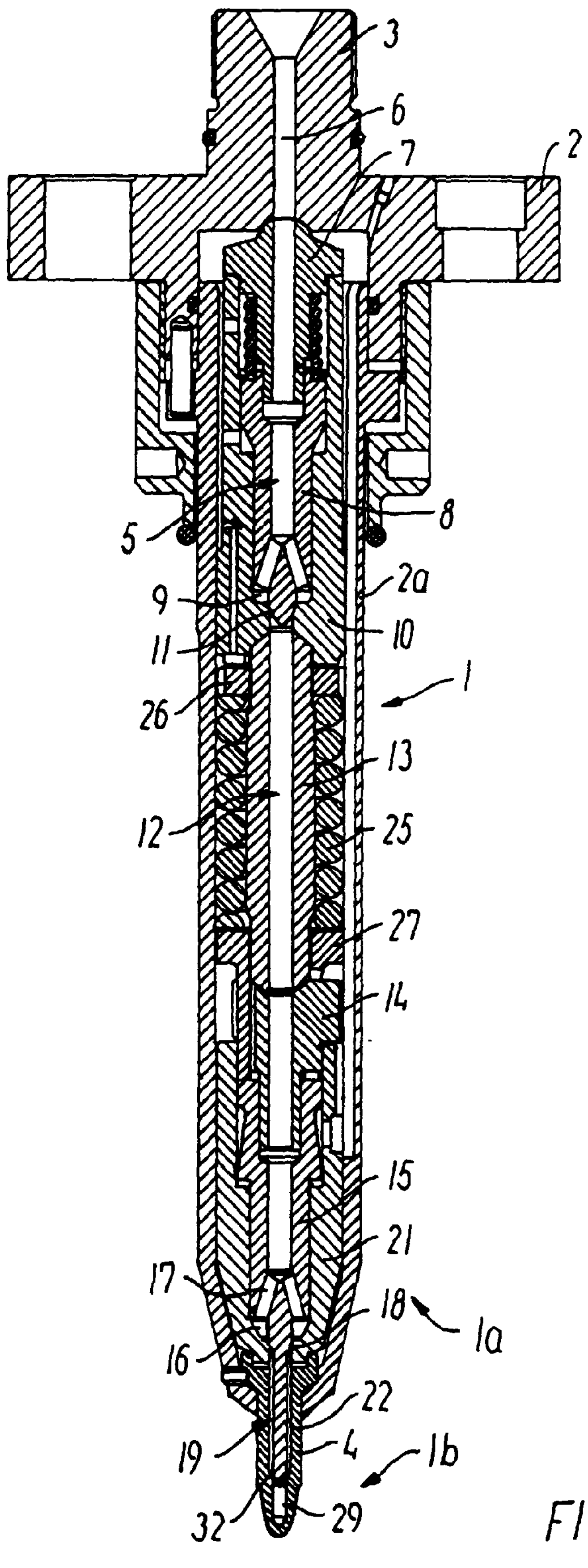



FIG. 1

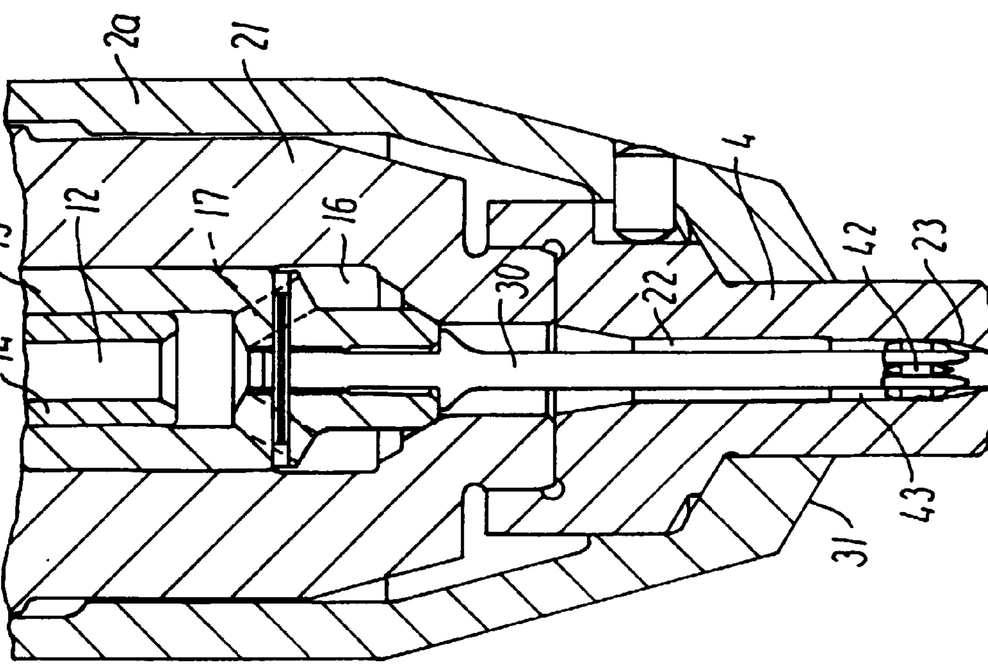

2a
21
15
12
17
16
14
30
22
4
42
23
29
24
43
31

FIG.3

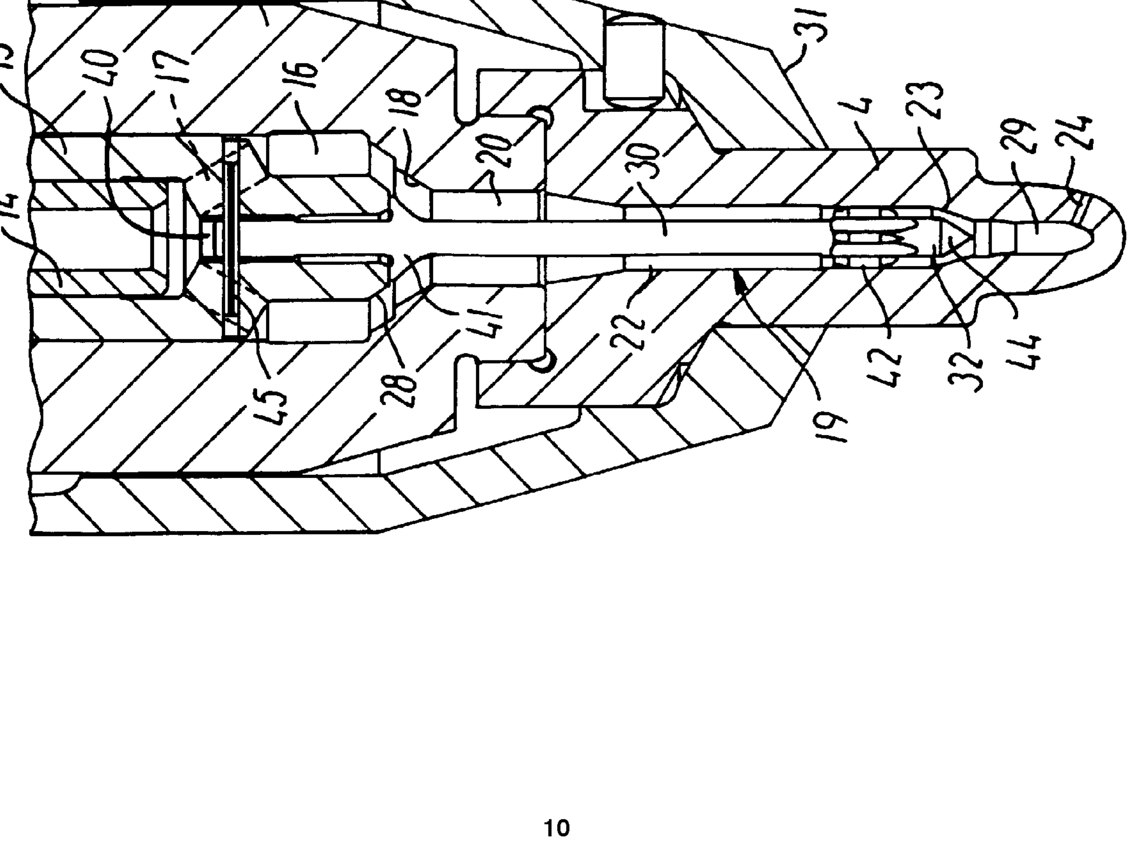
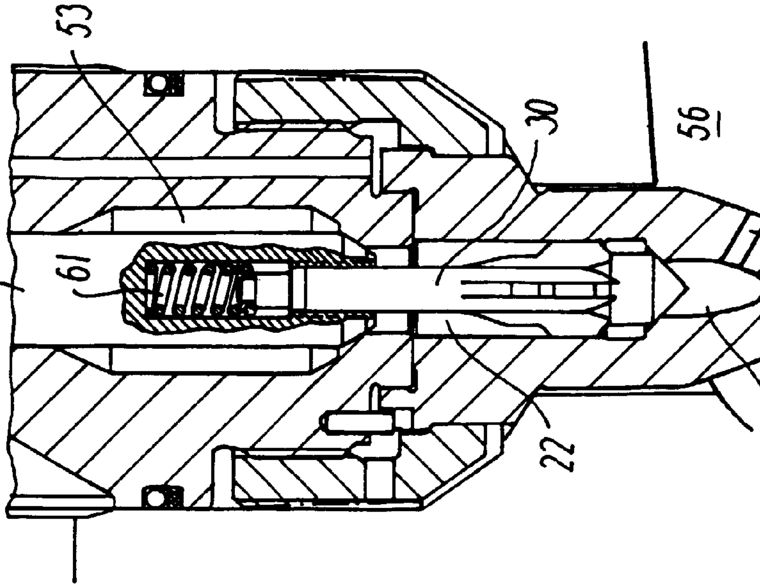
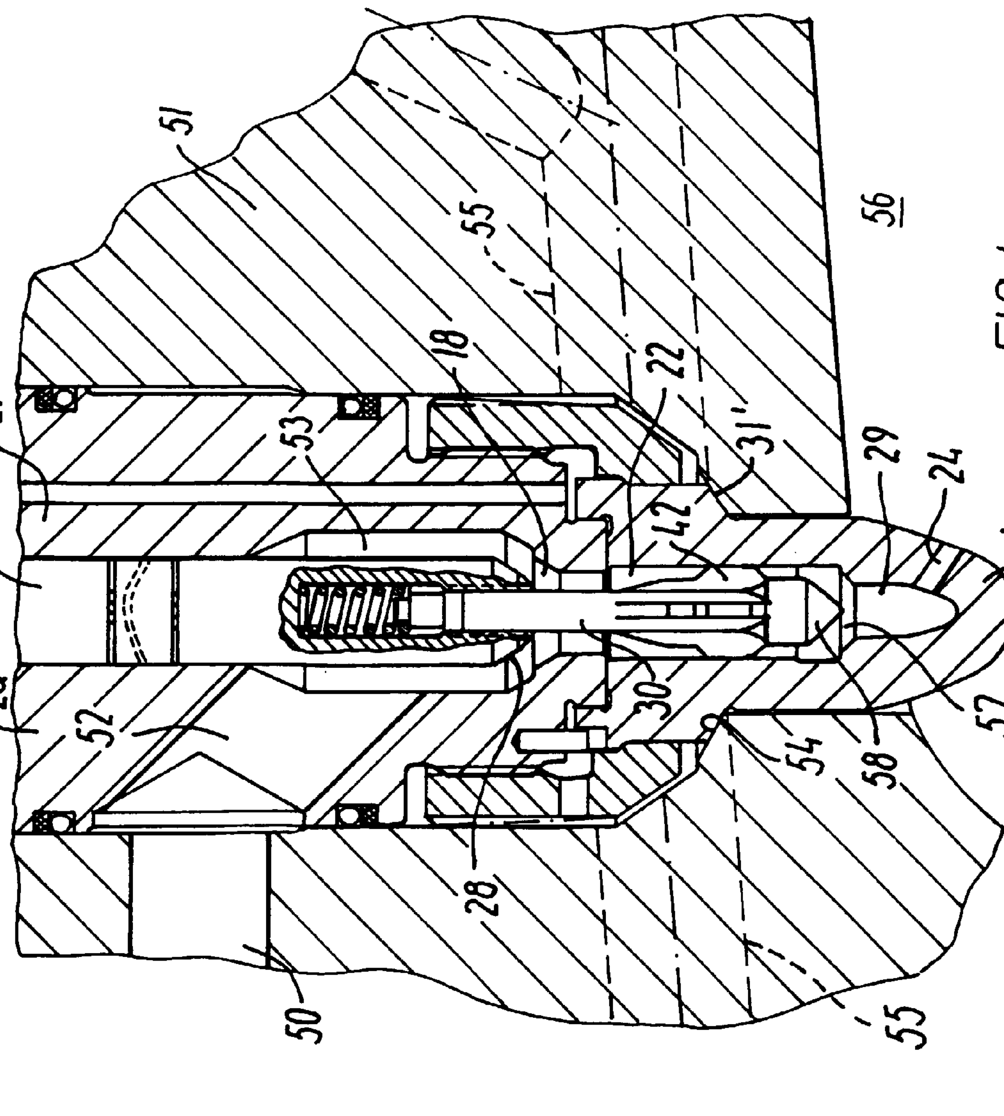

2a
21
15
40
17
16
14
18
20
31
30
4
23
29
24
45
28
41
22
19
42
32
44

FIG.2



53
15
61
30
56
24
4
29
22


FIG.5



51
55
56
21
15
53
18
22
31'
29
24
2a
52
42
4
30
54
58
57
28
50
55


FIG.4

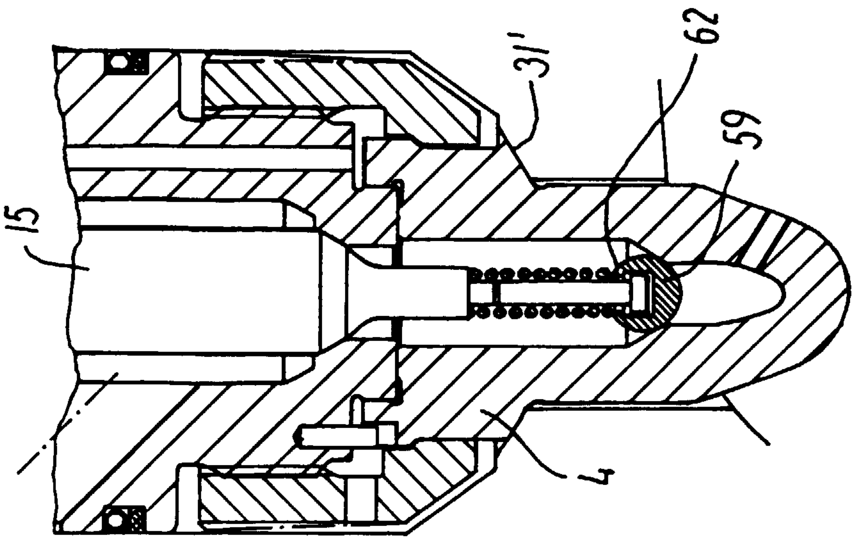



FIG.7

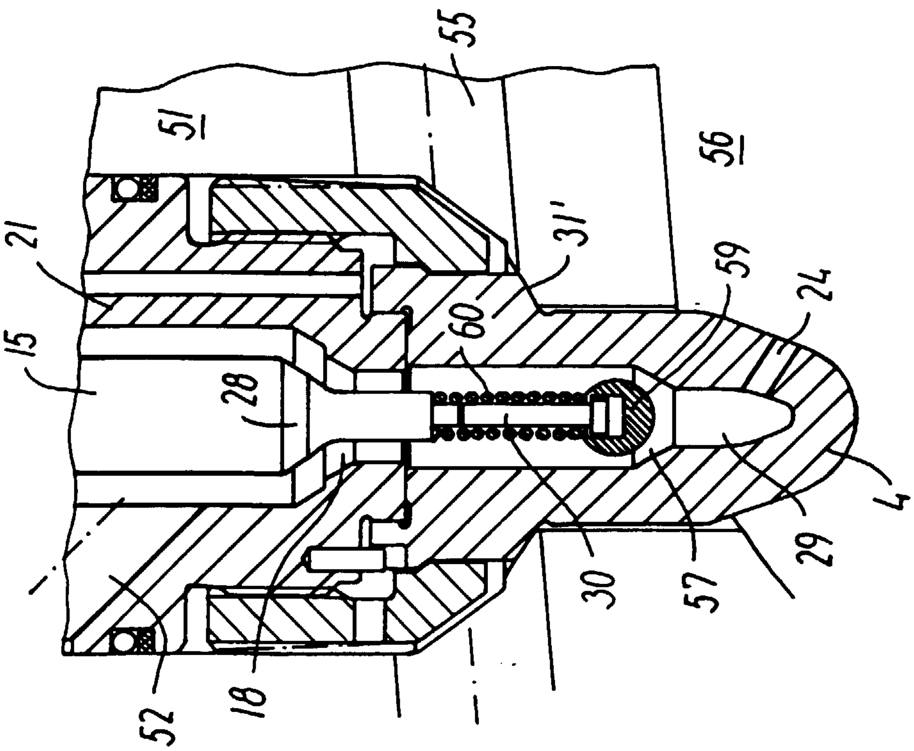



FIG.6