

Nov. 12, 1957

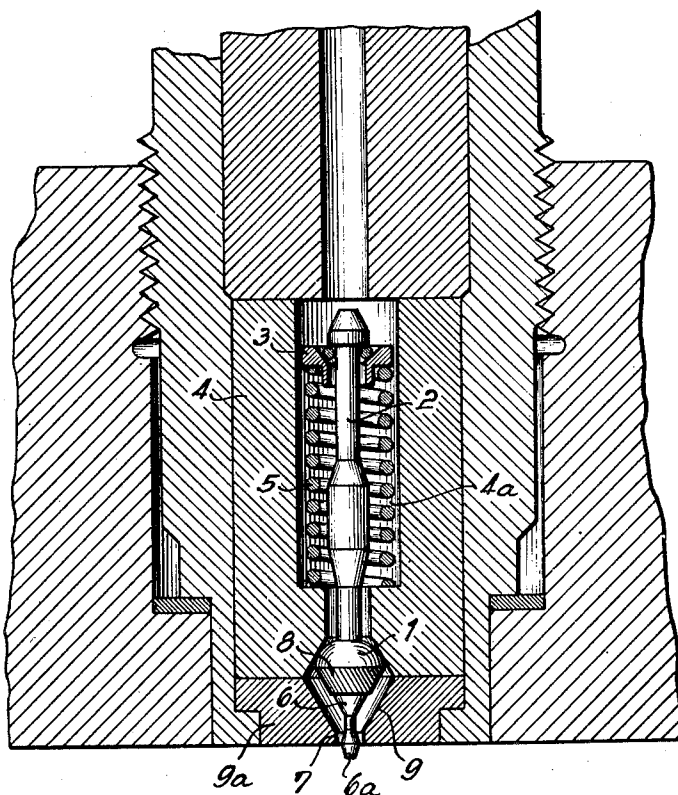
K. ZIESCHE ET AL
FUEL INJECTION VALVE

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3 Sheets-Sheet 1

FIG. 1



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FIG. 2

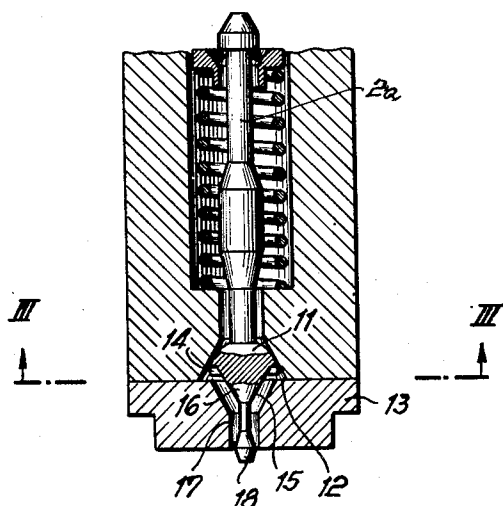
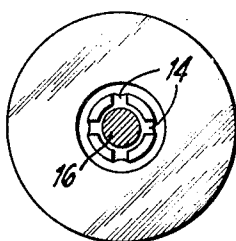


FIG. 3



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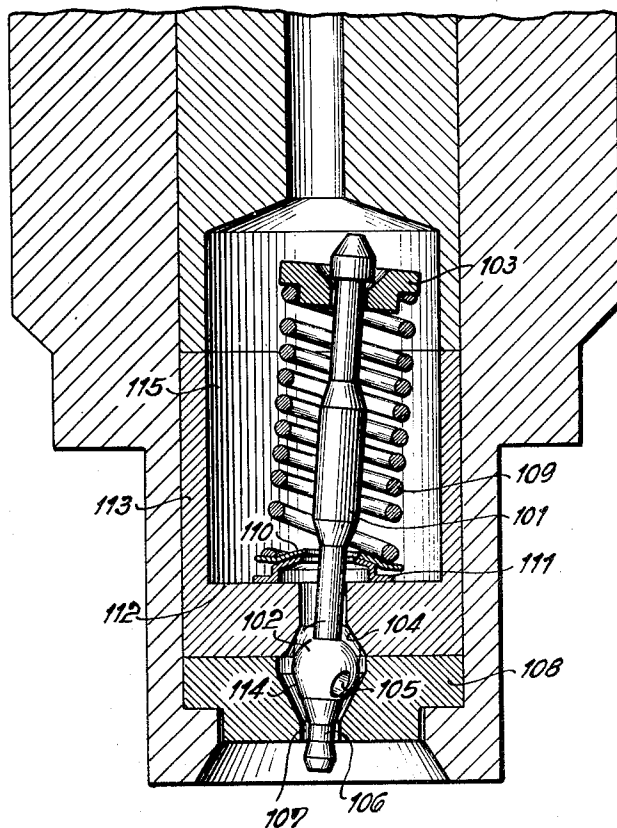
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FIG. 4



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FUEL INJECTION VALVE

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The present invention relates to fuel injection valves and, more particularly, is directed to a fuel injection valve having a closing body suspended in a pendulum-like manner for use in connection with internal combustion engines.

It is an object of this invention to provide an improved fuel injection valve of the above mentioned type which will assure that the fuel will equally well be atomized when starting the internal combustion engine and driving the same at low speed as well as at high speed.

It is still another object of this invention to provide a fuel injection valve which will impart a rifling movement upon the fuel after the latter has passed the closing body of the valve to thereby produce a widely atomized fuel jet.

Still another object of this invention consists in providing a fuel injection valve of the type set forth in the preceding paragraphs, in which the stroke of the closing body is limited without interrupting the flow of fuel to the injection opening.

Still another object of this invention consists in the provision of a fuel injection valve of the above mentioned type which has improved self-centering characteristics with regard to the openings through which the fuel passes in atomized condition.

These and other objects and advantages of the invention will appear more clearly from the following specification in connection with the accompanying drawings, in which:

Fig. 1 illustrates a longitudinal section through the valve casing with a valve according to the present invention, said valve being provided with cone-shaped stroke-limiting means.

Fig. 2 is a longitudinal section similar to that of Fig. 1 of a valve according to the invention having a stroke-limiting surface substantially perpendicular to the longitudinal axis of the valve.

Fig. 3 is a section taken along the line III—III of Fig. 2.

Fig. 4 is a longitudinal section through another modification of an injection valve according to the invention.

General arrangement

The primary feature of the fuel injection valve according to the present invention consists in that that side of the suspended closing body which is adjacent the combustion chamber of the cylinder or cylinder head controlled thereby, is provided with a stud-like extension which widens in a cone-shaped manner towards said combustion chamber, and is arranged in a bore having a diameter slightly larger than the largest diameter of said extension and directly leading into said combustion chamber. The arrangement is such that during the injection operation, at least at larger opening strokes of said valve, the portion of largest diameter of said extension moves out of said bore.

Since with fuel injection valves having a closing mem-

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ber suspended in pendulum-like fashion, the closing member will in its opening position center itself within the fuel passing around said closing member, provided the point of suspension in closing position of said closing member is located vertically over the center of the area confined by the sealing circle along which the closing member rests on the valve seat, also the stud carried according to the invention by the closing member will center itself within the narrow bore surrounding said stud. When the closing body carries out short strokes only, the stud will release only small annular spaces, whereas with increasing strokes, larger annular passages will be released due to the cone-shaped design of the said stud. This means that during the starting operation of the internal combustion engine and at low speed thereof, the fuel will during the injection operation be atomized in as good condition as will be the case at high speeds of the said engine.

According to a further development of the fuel injection valve according to the invention, the closing body of the valve may be so designed that it will taper toward the combustion chamber in a cone-like manner while the thus formed cone-shaped surface is provided with rifling grooves in a manner known per se. In this way a rifling movement will be imparted upon the fuel while it passes through said grooves as a result of which a wide atomized fuel jet will pass through the annular clearance released by the said stud. When the rifling grooves on the closing body extend in radial direction a pointed slender jet will be obtained.

According to a still further development of the present invention, the stroke of the closing body may be limited by a cone-shaped surface of the casing which extends parallel to the above-mentioned cone-shaped grooved surface of the closing body.

In order to hinder the centering of the valve as little as possible, it is advantageous to limit the stroke of the closing body by means of an annular surface in the casing, which surface is substantially perpendicular to the longitudinal axis of the valve. The shape of the fuel jet can then furthermore be influenced by providing the circumference of the closing body with straight or rifling grooves which lead into the annular surface of the closing body, which surface cooperates with the stroke limiting surface in the casing. The said grooves are at their mouth of such a depth that the fuel flow to the injection opening will not be interrupted when the closing body engages the valve seat.

Preferably the closing body is so designed that it tapers in a cone-shaped manner from the cross-section engaged by said grooves towards the combustion chamber, and is preferably surrounded in spaced relationship within the range of said cone-shaped surface by a parallel casing surface.

As stated above, with the new valve referred to in the preceding paragraphs, the closing body as well as the stud carried thereby center themselves in the two bores pertaining thereto. However, the valve casing which comprises the valve seat and the nozzle plate comprising the cylindrical bore surrounding the stud have to be manufactured as separate parts and have to be centered with regard to each other. If the nozzle plate is not precisely centered with regard to the valve casing, it is necessary with the fuel injection valve described above that when the valve closes, the closing body centers the nozzle needle with regard to the sealing surface, whereas when the valve is open, the stud centers the nozzle needle with regard to the injection bore. Consequently, the closing body has during each opening and closing to perform a lateral movement which may affect the quality of the injection step, and may also bring

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about a faster wear of the valve seat for the closing body. A certain inaccuracy in the centering between valve casing and nozzle plate cannot be avoided during the normal manufacturing process. Such inaccuracy may, if desired, be prevented by a careful and therefore time consuming and expensive special machining operation. However, according to the present invention, the above-mentioned drawback can be avoided when care is taken that the nozzle needle can swing freely in a pendulum fashion not only in its spring collar which is arranged at that side of the needle which is remote from the combustion chamber, but that the entire nozzle needle, including its closing spring, can swing about the center of the spherical seat surface of its closing body and can adjust itself so that its axis coincides with the connecting line of the seat surface cone and the center of the injection bore. Inasmuch as the cylindrical bore in the nozzle plate is relatively short, a slight inclination of the nozzle needle with regard to this bore has practically no influence upon the shape and direction of the jet. The free movability of the nozzle needle is obtained according to the invention by causing the closing spring to rest against the valve casing on a spherical surface, the center point of which coincides with the center point of the spherical closing body when the latter occupies its closing position. A spring collar may be provided between the spring and the casing, and if desired additionally an intermediate member may be provided which is correspondingly spherically shaped on that side which faces the spring collar and the other side of which rests against a plane step of the valve casing. A particularly favorable adjusting possibility for the nozzle valve is obtained when the said intermediate member is slidable on the said plane surface. The spring collar adjacent the combustion chamber and also the intermediate member may in a particularly simple manner be designed as pressed metal sheet parts.

Structural arrangement

Referring now to the drawings in detail and Fig. 1 thereof in particular, the fuel injection valve shown therein comprises a closing body 1 suspended by means of a shaft 2 on a spring collar or cap 3 in a pendulum-like fashion. The spring cap 3 is supported by a spring 5 arranged in a bore 4a of the valve casing 4. This spring is so designed that it normally holds the closing body 1 in its closing position shown in Fig. 1.

The closing body 1 carries an extension 6 in form of a stud which has a portion 6a widening in a cone-shaped manner toward the combustion chamber. The cone-shaped portion 6a is surrounded by a cylindrical bore 7, the diameter of which is slightly greater than the maximum diameter of the cone-shaped portion 6a. The portion 6a is so arranged within the bore 7 that it will leave the latter at least at larger strokes of the closing body 1. Due to its cone-shaped design, the portion 6a will, depending upon the valve stroke, leave a more or less greater clearance between the inner surface of the bore 7 and the extension 6. More specifically, with short strokes of the valve, small clearances, and with larger strokes, larger clearances between the extension 6 and the inner surface of the bore 7 will be obtained. In this way it is assured that also during the starting operation of the internal combustion engine and at low speed thereof, the fuel will enter the combustion chamber in a well atomized condition. With the valve shown in Fig. 1, the fuel enters the combustion chamber in a wide atomized condition because the closing body 1 tapers in a cone-shaped manner toward the extension 6, and the cone-shaped surface of the closing body 1 is provided with spiral or rifling grooves 8. The cone-shaped surface 9 of the plate 9a limits the stroke of the injection valve.

Referring now to the modification shown in Fig. 2, the valve illustrated therein has its closing body 11 pro-

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vided with a collar which at the end of the opening movement of the valve abuts an annular surface 12 in the valve casing 13, said surface 12 being substantially perpendicular to the longitudinal axis of the valve stem 2a. The circumference of the closing body is provided with grooves 14 which are so deep that when the closing body rests upon the surface 12, the fuel after passing around the semi-spherical closing body can still enter a cone-shaped clearance 15 confined by a cone-shaped extension 16 and the adjacent portion of the casing 13. This clearance finally merges with the guiding bore 17 for the stud 18. The vertical position of the abutment surface 12 with regard to the longitudinal axis of the valve stem has the advantage that when the valve abuts or rests on the surface 12, it will not be pressed toward the side, a danger which when employing cone-shaped valve seats exists due to certain minor inaccuracies which cannot be avoided during the production of the valve.

Referring now to Fig. 4, the nozzle needle 101 together with the closing body 102 is suspended on the spring cap 103 in the same manner as described above in connection with Fig. 1. The closing body 102 has a ball-shape and cooperates with a corresponding spherical seat 104. That end of the closing body 102 which faces the combustion chamber is similar to the closing bodies 1 and 11 of Figs. 1 and 2 provided with an extension 106 in form of a stud cooperating with a cylindrical bore 107 in the nozzle plate 108. The closing spring 109 has one end thereof resting against the spring cap 103 while the other end of the spring 109 rests against the spring cap 110. That portion of the spring cap 110 which faces away from the closing spring 109 is hemispherically shaped and rests upon an intermediate member 111 having its outer surface correspondingly hemispherically shaped. The other side of said intermediate member 111 rests upon a plane surface 112 forming the bottom of the bore 115 provided in the valve casing 113 and housing the spring 109. The intermediate member 111 is slidably arranged on said surface 112. In view of the flattened surface portions 114 of the closing body 102, it is assured that the fuel can pass by the closing body on all sides thereof even if the closing body occupies an eccentric position.

The drawing shows in an exaggerated manner an eccentric position of the cone-shaped surface 114 of the valve casing 113 with regard to the cylindrical bore 107 of the nozzle plate 108. However, due to the inclined position of the nozzle needle 101, the closing body 102, as well as the stud 106, can center themselves with regard to the bores pertaining thereto. During the opening and closing operation of the nozzle needle 101, the latter moves in the direction of its own axis only and does not carry out any lateral movement. Therefore, the closing body 101 does not have to center itself by a sliding movement, only when engaging the cone-shaped surface 104, but at once rests all the way around tightly on the cone-shaped surface 104.

It is, of course, to be understood that the present invention is by no means limited to the particular construction shown in the drawings, but also comprises any modifications within the scope of the appended claims.

What we claim is:

1. In a fuel injection valve having a casing with a valve seat, the combination of: a valve member suspended in said casing in a pendulum-like manner and provided with a closing body having an at least semi-spherical sealing surface for engagement with said valve seat, said valve casing also being provided with a cylindrical bore spaced from said valve seat and having a diameter considerably less than the smallest diameter of the sealing surface of said closing body when the latter engages said valve seat, extension means rigidly connected to said closing body and comprising a conical end portion widening in a direction away from said closing body, said conical end portion being at least in part located within said bore

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when said closing body is in engagement with said valve seat, the largest diameter of said extension means within said bore being less than the inner diameter of said bore so as to leave a clearance therebetween for the fuel to be injected, said valve casing also comprising a spring chamber surrounding a portion of said valve member, supporting means having a semi-spherical surface and supported by said valve casing, and spring means supported by said supporting means so as to allow movement of the longitudinal axis of said spring means relative to the longitudinal axis of said valve member, said spring means supporting said valve member in a pendulum-like manner, the curvature of the hemi-spherical surface of said supporting means being such that the center of curvature of said hemi-spherical surface coincides with the center of curvature of said closing body when the latter is in closing engagement with said valve seat.

2. In a fuel injection valve having a casing with a valve seat, and a valve member comprising a closing body at one end thereof with an at least hemi-spherical head for closing engagement with said valve seat in closing position of said closing body, the combination of: supporting means having a substantially hemi-spherical surface and supported by said casing, a spring, a spring cap supported by one end of said spring and supporting said valve member in a pendulum-like manner, the other end of said spring being supported by said supporting means, said valve casing also being provided with a bore arranged in spaced relationship to said valve seat and having a diameter considerably less than the diameter of that surface area of said closing body which engages said valve seat in closing position of said closing body, and extension means rigidly connected to said closing body and comprising a conical end portion widening in a direction away from said closing body, said conical end portion being at least in part located within said bore when said closing body is in engagement with said valve seat, the largest diameter of said extension means within said bore being less than the inner diameter of said bore so as to leave a clearance therebetween for the fuel to be injected, said spring means continuously urging said closing body into engagement with said valve seat.

3. In a fuel injection valve having a casing with a spring

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chamber housing a spring, a valve seat, and a valve member suspended in a pendulum like manner by said spring and comprising a closing body at one end thereof with an at least hemispherical head for closing engagement with said valve seat in closing position of said closing body, the combination of: a supporting member resting on the bottom of said spring chamber and being provided with a substantially hemi-spherical surface, a spring cap having a substantially hemi-spherical surface corresponding to that of said supporting member and being in sliding engagement therewith, said spring cap engaging one end of said spring, the other end of said spring acting on the adjacent end of said valve member, said valve casing also being provided with a bore arranged in spaced relationship to said valve seat and having a diameter considerably less than the diameter of that surface area of said closing body which engages said valve seat in closing position of said closing body, and extension means rigidly connected to said closing body and comprising a conical end portion widening in a direction away from said closing body, said conical end portion being at least in part located within said bore when said closing body is in engagement with said valve seat, the largest diameter of said extension means within said bore being less than the inner diameter of said bore so as to leave a clearance therebetween for the fuel to be injected.

4. A fuel injection valve according to claim 3, in which said supporting member is slidably mounted on the bottom of said spring chamber.

5. A fuel injection valve according to claim 3, in which said supporting member and said spring cap are pressed sheet metal parts.

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