Nov. 18, 1958 K. ZIESCHE ET AL 2,860,780

FUEL INJECTION VALVE

Original Filed Dec. 6, 1954

FIG. 1

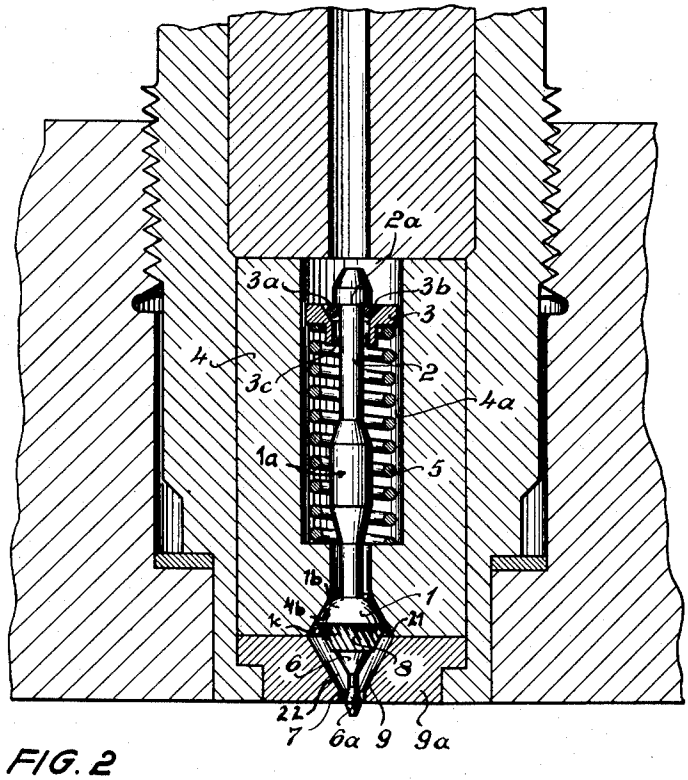


FIG. 2

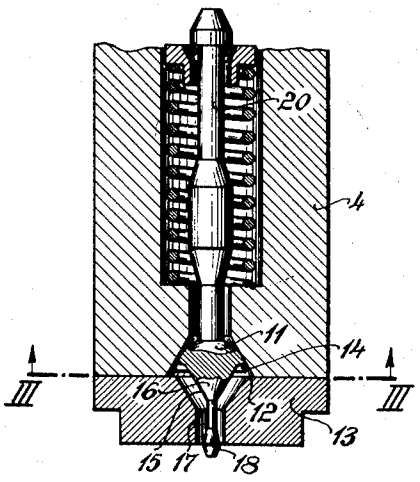
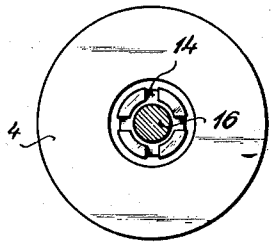


FIG. 3



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FUEL INJECTION VALVE

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Original application December 6, 1954, Serial No. 473,397, now Patent No. 2,812,979, dated November 12, 1957. Divided and this application May 22, 1957, Serial No. 660,913

Claims priority, application Germany December 12, 1953

5 Claims. (Cl. 299—107.6)

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. This application is a divisional application of our co-pending application Ser. No. 473,397 filed December 6, 1954, now Patent No. 2,812,979.

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.

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 member 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 of 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 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 in its spring collar which is arranged at that side of the needle which is remote from the combustion chamber.

Structural arrangement

Referring now to the drawings in detail and Fig. 1 thereof in particular, the fuel injection valve shown therein comprises a valve member generally designated **1***a* with a closing body **1**, a stem **2** and a stem head or shoulder **2***a*. As will be seen from Fig. 1, the closing body **1** is suspended in a pendulum-like manner on a spring collar or cap **3** by means of stem **2**, stem head or shoulder **2***a*, and rolling means **3***a*. The rolling means **3***a* preferably consists of a spring ring of substantially circular cross section and supports the head **2***a* while being movable in the cone-shaped portion **3***b* of the spring cap **3**. The cone-shaped portion **3***b* leads into a cylindrical bore **3***c* which has a considerably greater inner diameter than the outer diameter of the stem **2** so that the stem **2** can freely swing within the bore **3***c*. The spring cap **3** is supported by a spring **5** arranged in a bore **4***a* 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, in which the hemispherical surface portion **1***b* of the body **1** engages the valve seat **4***b* which latter forms a part of the cone-shaped or frustrated cone-shaped chamber **21**. The chamber **21** merges with a similar but inversely arranged conical chamber **22**.

The closing body **1** carries an extension **6** in form of a stud which has a portion **6***a* widening in a cone-shaped manner toward the combustion chamber. The cone-shaped portion **6***a* is surrounded by a cylindrical bore **7**, the diameter of which is slightly greater than the maximum diameter of the cone-shaped portion **6***a*. The portion **6***a* 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 **6***a* 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 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 **1***c* of the closing body **1** is provided with spiral or rifling grooves **8**. The cone-shaped surface **9** of the plate **9***a* 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** provided with a collar which at the end of the opening movement of the valve abuts an annular surface or shoulder **12** in the valve casing **13**, said surface **12** being substantially perpendicular to the longitudinal axis of the valve stem **20**. The circumference of the closing body is provided with radial 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 fact that the abutment surface **12** is perpendicular 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.

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 combination in a fuel injection valve: a casing having fuel passage means therethrough including a substantially vertical first bore and a frusto-conical shaped chamber arranged below said bore in substantially axial alignment therewith and provided with a frusto-conical valve seat for conveying fuel therethrough to a combustion chamber, said passage means also including an injection bore communicating with said frusto-conical shaped chamber and in substantially axial alignment therewith while being arranged below said valve seat, a valve member including a stem extending into said first bore and having its upper end provided with a shoulder and having its lower end provided with a closing body located within said frusto-conical shaped chamber, said closing body having a hemispherical surface for engagement with said valve seat, supporting means adjacent said shoulder, spring means resting in said first bore while having its upper end in engagement with said supporting means so as continuously to urge the same upwardly, said supporting means comprising a spring collar having an axial bore therethrough comprising a lower cylindrical portion of a diameter considerably greater than the diameter of the adjacent stem portion of said valve member and having an adjacent upper frusto-conical portion tapering toward said cylindrical portion and being spaced from said shoulder, rolling means arranged in said frusto-conical portion and in engagement with said shoulder to thereby suspend said valve member so as to allow tilting movement thereof in any direction, and an extension member rigidly connected to the bottom portion of said closing body, said extension member having a frusto-conical control surface section widening in a direction away from said stem and extending into said injection bore, the largest diameter of said control surface section within said injection bore when said valve member engages said valve seat being slightly less than the diameter of said injection bore so as to leave a clearance therebetween for the fuel to be injected and to allow tilting movement of said extension member within said injection bore when said valve member tilts about said supporting means, said frusto-conical control surface section being operable gradually to increase the space between the latter and said injection bore in response to the downward movement of said valve member against the thrust of said spring means.

2. A fuel injection valve according to claim 1, in which said rolling means consists of a spring ring of substantially circular cross section.

3. In combination in a fuel injection valve: a casing having fuel passage means therethrough including a substantially vertical first bore and a frusto-conical shaped chamber arranged below said bore in substantially axial alignment therewith and provided with a frusto-conical valve seat for conveying fuel therethrough to a combustion chamber, said passage means also including an injection bore communicating with said frusto-conical shaped chamber and in substantially axial alignment therewith while being arranged below said valve seat, a valve member including a stem extending into said first bore and having its upper end provided with a shoulder and having its lower end provided with a closing body located

within said frusto-conical shaped chamber, said closing body having a first surface section of substantially semi-spherical shape for sealing engagement with said valve seat and having a second surface section of frusto-conical shape adjacent to said first surface section and tapering in a direction away from the latter, said second surface section being provided with rifling grooves, supporting means adjacent said shoulder, spring means resting in said first bore while having its upper end in engagement with said supporting means so as continuously to urge the same upwardly, said supporting means comprising a spring collar having an axial bore therethrough comprising a lower cylindrical portion of a diameter considerably greater than the diameter of the adjacent stem portion of said valve member and having an adjacent upper frusto-conical portion tapering toward said cylindrical portion and being spaced from said shoulder, rolling means arranged in said frusto-conical portion and in engagement with said shoulder to thereby suspend said valve member so as to allow tilting movement thereof in any direction, and an extension member rigidly connected to the bottom portion of said closing body, said extension member having a frusto-conical control surface section widening in a direction away from said stem and extending into said injection bore, the largest diameter of said control surface section within said injection bore when said valve member engages said valve seat being slightly less than the diameter of said injection bore so as to leave a clearance therebetween for the fuel to be injected and to allow tilting movement of said extension member within said injection bore when said valve member tilts about said supporting means, said frusto-conical control surface section being operable gradually to increase the space between the latter and said injection bore in response to the downward movement of said valve member against the thrust of said spring means.

4. In combination in a fuel injection valve: a casing having fuel passage means therethrough including a substantially vertical first bore and a frusto-conical shaped chamber arranged below said bore in substantially axial alignment therewith and provided with a frusto-conical valve seat for conveying fuel therethrough to a combustion chamber, said passage means also including an injection bore communicating with said frusto-conical shaped chamber and in substantially axial alignment therewith while being arranged below said valve seat, a valve member including a stem extending into said first bore and having its upper end provided with a shoulder and having its lower end provided with a closing body located within said frusto-conical shaped chamber, said closing body having a hemispherical surface for engagement with said valve seat and being provided with a collar, said frusto-conical shaped chamber being provided with a shoulder at that end thereof which is remote from said first bore for engagement with said collar to thereby limit the maximum downward stroke of said valve member, supporting means arranged adjacent said first mentioned shoulder, spring means resting in said first bore while having its upper end in engagement with said supporting means so as continuously to urge the same upwardly, said suporting means comprising a spring collar having an axial bore therethrough comprising a lower cylindrical portion of a diameter considerably greater than the diameter of the adjacent stem portion of said valve member and having an adjacent upper frusto-conical portion tapering toward said cylindrical portion and being spaced from said first mentioned shoulder, rolling means arranged in said frusto-conical portion and in engagement with said first mentioned shoulder to thereby suspend said valve member so as to allow tilting movement thereof in any direction, and an extension member rigidly connected to the bottom portion of said closing body, said extension member having a frusto-conical control surface section widening in a direction away from said stem and extending into said injection bore, the largest diameter of said control surface section within said injection bore when said valve member engages said valve seat being slightly less than the diameter of said injection bore so as to leave a clearance therebetween for the fuel to be injected and to allow tilting movement of said extension member within said injection bore when said valve member tilts about said supporting means, said frusto-conical control surface section being operable gradually to increase the space between the latter and said injection bore in response to the downward movement of said valve member against the thrust of said spring means.

5. A fuel injection valve according to claim 4, in which the bottom portion of said collar is provided with radial grooves.

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