April 22, 1958 W. PFLAUM 2,831,730

NOZZLE, PARTICULARLY FUEL-INJECTING NOZZLE FOR INTERNAL COMBUSTION ENGINES

Filed June 27, 1955 2 Sheets-Sheet 1

Fig. 1

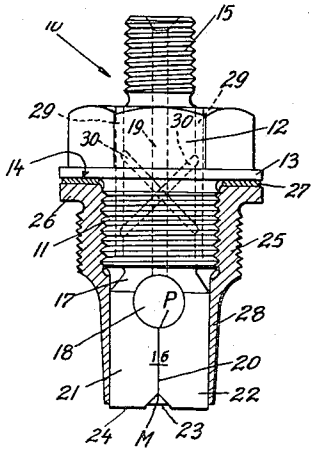


Fig. 2

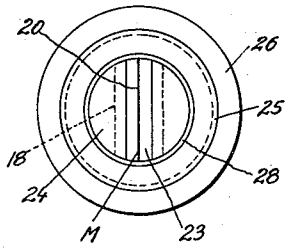


Fig. 3

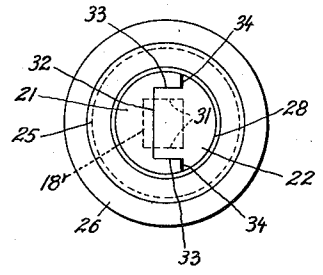


Fig. 4

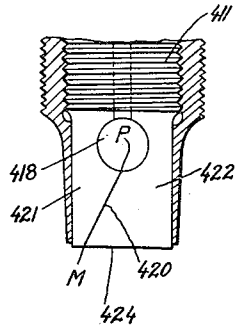
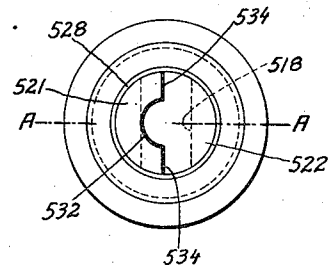


Fig. 5



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April 22, 1958 W. PFLAUM 2,831,730

NOZZLE, PARTICULARLY FUEL-INJECTING NOZZLE FOR INTERNAL COMBUSTION ENGINES

Filed June 27, 1955 2 Sheets-Sheet 2

Fig. 6

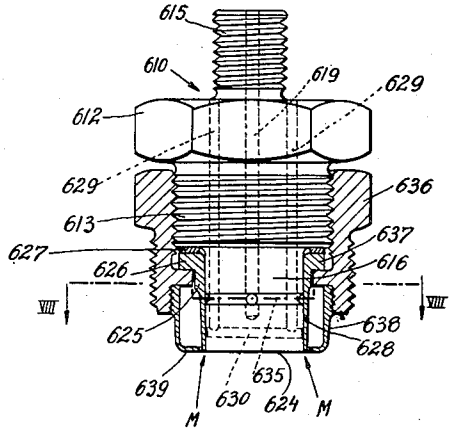


Fig. 7

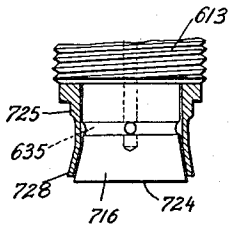


Fig. 8

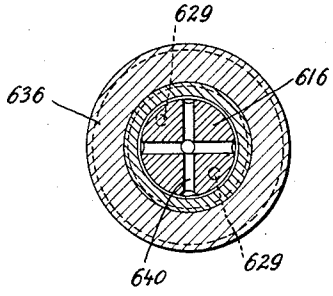
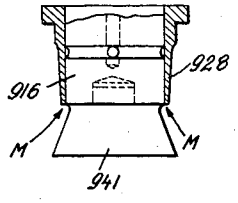


Fig. 9



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NOZZLE, PARTICULARLY FUEL-INJECTING NOZZLE FOR INTERNAL COMBUSTION ENGINES

Walter Pflaum, Berlin-Wannsee, Germany

Application June 27, 1955, Serial No. 518,320
Claims priority, application Germany June 1, 1956
5 Claims. (Cl. 299—107.3)

My invention relates to a nozzle, particularly a nozzle of the type which opens automatically in response to internal pressure of a liquid supplied to the nozzle and emits a jet of liquid and then closes automatically, such as used in internal combustion engines for the purpose of intermittently injecting charges of fuel into the cylinders of the engines.

It is the object of my invention to provide an improved nozzle of great simplicity which may be manufactured at low cost and requires a minimum of service and maintenance and yet is extremely reliable in operation.

It is a further object of my invention to provide an improved nozzle which opens automatically in response to pressure of liquid supplied thereto and will emit a jet of atomized fuel composed of minute globules having a high penetrating power for the purpose of even distribution of the fuel throughout a large volume of air.

It is another object of my invention to provide an improved nozzle equipped with means for shaping and directing in an appropriate manner a jet of atomized fuel issuing from the nozzle mouth.

Among further objects of the invention are to provide a fuel-injecting nozzle for internal combustion engines that is normally closed, but will open in response to the admission thereto of a fuel under pressure, but will not open in response to the pressure arising in the cylinder of the engine, and to provide an improved atomizing nozzle of a type indicated hereinabove which is composed of a minimum number of elements cooperating without mutual friction and thus being free of wear.

Further objects of my invention will appear from a detailed description of a number of embodiments thereof following hereinafter with reference to the accompanying drawings. It is to be understood, however, that the terminology and phrases used hereinafter serve the sole purpose of illustrating the invention and are not intended to restrict or limit the same. The features for which protection is sought are defined in the appended claims.

In the drawings,

Fig. 1 is an elevation of a fuel-injecting nozzle for an internal combustion engine including an outer sleeve element shown in section,

Fig. 2 is a front view of the nozzle shown in Fig. 1 showing the mouth of the nozzle,

Fig. 3 is a view similar to that of Fig. 2 of a modified fuel-injecting nozzle for an internal combustion engine,

Fig. 4 is a partial view similar to that of Fig. 1 of a third modification of the improved fuel-injecting nozzle,

Fig. 5 is a front view of another modification of the fuel-injecting nozzle,

Fig. 6 is an elevation of a fuel-injecting nozzle embodying the present invention, the outer elements surrounding a solid core being shown in axial section,

Fig. 7 is a view similar to the lower central portion of Fig. 6 of a modification of the nozzle shown therein,

Fig. 8 is a transverse section taken along the broken line VIII—VIII of Fig. 6, and

Fig. 9 is a view similar to Fig. 7 of still another modification of the nozzle shown in Fig. 6.

The automatic fuel-injecting nozzle for an internal combustion engine which is illustrated in Fig. 1 comprises a core element 10 having a threaded central cylindrical portion 11, an adjoining hexagonal portion 12 with a collar 13 therebetween forming a shoulder 14, an upper threaded portion 15 of reduced diameter, and a cylindrical lower or front portion 16 joined to the central portion 11 by a neck portion 17 of reduced diameter. A transverse bore 18 extends through the front portion 16 and the neck portion 17. From the bore 18 an axial bore 19 extends upwardly through the portions 11, 13, 12 and 15. The front portion 16 of the core is longitudinally split to form a pair of legs 21 and 22 having semicircular cross sections and being normally in contact with each other so as to close the crevice 20 between them. This crevice may terminate in a diametrical groove 23 provided in the plane front face 24 of the core. An internally threaded bushing 25 is screwed on the threaded portion 11 of the core and has a flange 26, a sealing washer 27 being placed between the flange 26 and the shoulder 14. The bushing 25 is integral with a thin sleeve 28 which closely surrounds the cylindrical portion 16 preferably with a pressed seat which will bias the sleeve 28, that is to say set up a circumferential tensional stress therein thus normally pressing the legs 21, 22 upon each other with a certain force. Preferably the sleeve 28 extends substantially to the front face 24 of the nozzle, but it may terminate a slight distance short thereof, or alternatively may slightly project therebeyond.

The upper threaded portion 15 serves to receive a nipple not shown for the connection thereto of a fuel pipe connected to the fuel pump of the engine and thus constitutes a means for admitting a fluid, to wit liquid fuel under pressure.

The operation is as follows: When the fuel charge is admitted under pressure into the axial bore 19 and the transverse bore 18 connected therewith, the internal pressure arising in bore 18 will tend to spread the legs 21 and 22 apart permitting the liquid at point P to enter the crevice 20 thus permitting the pressure to act on an increased surface and to further enlarge the crevice until the fuel reaches the lower mouth M of the crevice and issues from the groove 23 in form of a jet of atomized fuel composed of minute globules which have a very high speed and, therefore, a high penetrating power. The pressure under which the liquid flowing through the crevice or gap 20 is held depends on both the bias of sleeve 28 and on the bending stress set up in the neck portion 17, the latter again depending on the diameter of the neck portion 17. This diameter, the thickness of the sleeve portion 28, and the resiliency of the materials employed for the sleeve 28 and the core 16, 17, 11 etc. are so chosen that the cross section of the mouth of the gap 20 opening automatically is the desired function of the super-pressure of the fuel in bore 18, such function having a suitable characteristic. Therefore, the fuel will be released from the mouth of the crevice 20 at a great pressure.

The bushing 25 with the sleeve-shaped portion 28 has the additional function of laterally sealing both the bore 18 and the crevice 20 so that the fuel will issue from the diametrical mouth only traversing the front face 24 of the nozzle, as shown in Fig. 2. When the pressure produced by the fuel pump drops below a certain limit, the crevice 20 will be closed automatically by the bending stress set up in the neck portion 17 of the legs 21, 22 and by the inwardly directed pressure exerted upon the legs by the biassed sleeve portion.

Preferably the core is formed with a duct for a cooling liquid. In the embodiment shown, this duct is formed

by four bores 29 provided parallel to the axis of the core at equal distances from each other and from the axis thereof and extending from the top face of the hexagonal portion 12 into the recess surrounding the neck portion 17. Each of these bores 29 is plugged up at the bottom thereof, and the bores are suitably interconnected by slanting bores 30 so as to establish a cooling circuit permitting to cool the portion 11 of the core directly and the legs 21, 22 thereof indirectly.

Where the diameter of the neck portion 17 exceeds that of bore 18 considerably, the bores 29 may extend down into the legs 21, 22. The transverse bores 30 must be positioned in different planes, of course, so as to avoid mutual intersection.

From the foregoing explanation it will appear that my novel nozzle comprises a number of elements, such as the sleeve 28 and the legs 21 and 22, which are shaped and associated to form a mouth that is normally closed, and that the nozzle further comprises means, such as 15, for admitting a fluid under pressure between the elements to spread same apart thereby opening the mouth and causing a jet of fluid to issue therefrom. At least one element, to wit element 28, constitutes a sleeve surrounding the elements 21 and 22, the sleeve being of a resiliency permitting it to undergo an expansion by the pressure exerted by the liquid, such expansion being instrumental in the opening of the mouth.

The fluid is admitted under pressure between the elements 21 and 22 at the point P, that is to say at a point spaced from the mouth M. The two legs 21 and 22 are integral with the common neck portion 17. Hence, this portion constitutes a rigid unit rearwardly at the point P.

Viewed from another aspect, the legs 21, 22 constitute lengthwise extending adjoining relatively movable elements adapted to confine at least one fluid-conducting gap 20 at the joint between them extending lengthwise through the interior of the core to the front end 24 thereof.

The surface of revolution constituting the periphery of core portion 16 need not be cylindrical as shown, but may have any other suitable shape. Thus, it may be slightly conical for instance. This affords an opportunity of varying the bias of sleeve 28 by axial displacement thereof. For this purpose, the washer 27 may be replaced by another washer of greater or lesser thickness. If desired, the external threads of core portion 11 and the internal threads of bushing 25 may be omitted and bushing 25 may be screwed to the core by other suitable means permitting relative axial displacement between the bushing and the core, for instance in the manner explained hereinafter with reference to Fig. 6. Where core portion 16 is conical, the internal face of sleeve 28 may be so shaped as to contact this portion throughout its length, or at least over a peripheral zone at the lower end of the sleeve.

The embodiment illustrated in Fig. 3 differs from that described hereinabove with reference to Figs. 1 and 2 by the shape of the crevice between the leg portions 21, 22 and by the length of bore 18. In lieu of a bore 18 extending from one side of the core portion 16 to the other, the bore 18' is restricted to the central portion of the core being confined by opposite parallel end walls 31 extending parallel to the axis of the core. While in Fig. 1 the crevice is formed by adjoining plane faces extending axially and diametrically, the crevice in the embodiment shown in Fig. 3 is composed of relatively angularly disposed sections, all of which are spaced from and extend parallel to the axis of the core. They comprise a central section 32 joining parallel sections 33 extending parallel to each other and being of equal length and terminating in end sections 34 which extend outwardly up to the side surface of core portion 16 parallel to the central section 32. The groove 23 is preferably omitted.

Because of the reduced length of bore 18' fuel is admitted to the central section 32 of the crevice only. In this embodiment the fuel will not be able to widen the sections 33 of the crevice and, therefore, the fuel will have no access to the periphery of the core portion 16. When the two legs 21 and 22 of the core are spread apart this will have the sole effect of widening the sections 32 and 34 of the crevice. As the fuel cannot flow through the sections 33, however, the gaps formed at 34 will remain vacant. Therefore, the mouth of the nozzle in this embodiment coincides with the central section 32 of the crevice only and does not extend to the edges of the front face 24.

In the embodiment shown in Fig. 4 the neck portion 17 of the core has been omitted. In order to provide for the required resiliency of the legs 421 and 422 of the central portion 411 of the core, the bore 418 must have a comparatively large diameter which is so chosen as to obtain the desired characteristics of the nozzle. Moreover, this nozzle differs from that shown in Fig. 1 in that the plane crevice 420 extending from the central line P to the straight mouth M extends at an acute angle to the axis of the nozzle. Therefore, the straight mouth M is spaced from the center of the front face 424.

The principles illustrated in Figs. 3 and 4 may be suitably combined by extending the central section 32 of the crevice shown in Fig. 3 at an acute angle to the axis to a centrally located line P if desired.

While P is a straight line in all of the embodiments described heretofore, it may have any other desired shape. Thus, for instance, Fig. 5 illustrates an embodiment in which the mouth is formed by a central semi-circular portion 532 of the crevice and by two adjoining straight sections 534 of the crevice. The sections 534 are disposed diametrically, while section 532 is concentric to the axis. The transverse bore 518 of the core terminates in the periphery of core front portion composed of the legs 521 and 522. When these legs are spread apart expanding sleeve 528, the mouth will be opened substantially throughout its length.

While in all of the embodiments heretofore described the front nozzle portion, such as 16, is split by a single crevice thus forming two legs 21 and 22, any desired number of crevices may be provided so as to split the nozzle portion into any desired number of legs and so as to form any desired number of mouths M.

In the embodiment shown in Fig. 5 the starting line of the crevice, such as line P, may be a straight line. In that event, a transverse section taken along the line A—A would be similar to Fig. 4 showing that the jet issuing from the central portion of the mouth would be inclined to the axis, whereas the jets issuing from the end sections 534 would be parallel to the axis.

Alternatively, however, the central section 532 of the crevice may be semi-cylindrical so as to direct the issuing jet substantially parallel to the axis.

The automatic fuel-injecting nozzle illustrated in Fig. 6 comprises a rigid core 610 of circular cross section provided with a peripheral groove 635 and with a duct 619 communicating therewith for the admission of fuel under pressure. As described with reference to Fig. 1, the core has an outer or rear threaded portion 615 for the admission of fuel, an adjoining hexagonal portion 612, a central cylindrical portion 613, and a cylindrical front portion 616 of reduced diameter. It is this portion 616 which is provided with the peripheral groove 635. In distinction to the embodiments heretofore described, however, the front portion 616 of the core 610 is not split. The crevice or gap is formed by the peripheral surface of portion 616 in cooperation with the contacting internal surface of the sleeve portion 628 of bushing 625. Here again the sleeve portion 628 is press-fitted on the cylindrical core portion 616 to make certain that the gap or crevice is normally closed and will not open unless fuel under considerable pressure is introduced through the axial bore 619 to the peripheral groove 635.

The flange 626 of the bushing 625 is held against the sealing washer 627 contacting the shoulder of the central core portion 613 by a nipple 636 which is screw-threaded on external threads provided on central core portion 613 and has an internal flange 637 engaging the flange 626 of the bushing 625. In this manner, the sleeve portion 628 may be slipped on the front portion 616 of the core under great pressure by screwing the nipple 636 on the core.

The sleeve portion 628 which may consist of steel or any other suitable metal is so thin that it will spread apart from the cylindrical portion 616 by the pressure of fuel admitted to the groove 635 thereby permitting a jet of fuel to be emitted from between the sleeve 628 and the cylindrical core portion 616.

Preferably, means are provided to limit the expansion or spreading motion of the sleeve portion 628. In the embodiment shown, such means comprises a bushing 638 which has external threads engaging internal threads at the lower end of nipple 636. The bushing 638 has an internal flange 639 at its end which confronts the lower margin of sleeve portion 628 at a slight distance therefrom. Thus, the radial expansion of the sleeve portion 628 of the bushing 625 is limited by the internal edge of flange 639, the diameter of this internal edge being larger than the external diameter of the lower end of sleeve portion 628. The restriction of the expansion of the sleeve has a favorable influence on the shape of the jet issuing from the mouth M of the nozzle. The bushing 638 has the additional function of screening the resilient sleeve 628 from heat radiation.

The communication between the central bore 619 and the peripheral groove 635 is preferably established by a plurality of radial bores 640, as shown in Fig. 8. In this manner, the pressure exerted by the fuel will be uniformly distributed over the entire periphery of the core portion 616 thus ensuring that the circular mouth M will open uniformly, even where the pressure rises abruptly as it happens in internal combustion engines. Here again the sleeve 625 preferably extends to the front face 624 of the nozzle, but may terminate a small distance short thereof, or may project slightly beyond the same. For this purpose, a washer 627 of a suitable thickness may be inserted. The core portion is provided with an internal cooling circuit constituted by bores 629 extending at equal distances from each other and from the axis parallel to the latter and connected by transverse bores 630 which may be placed close to the front face 624.

From the foregoing description it will appear that the automatic nozzle shown in Fig. 6 is similar to the nozzles described with reference to Figs. 1 to 5 in that it comprises a number of elements, such as 616 and 628, shaped and associated to form a mouth that is normally closed, and means 615 for admitting a fluid under pressure between the elements 616 and 628 to spread the same apart thereby opening the mouth M and causing a jet of fluid to issue therefrom, one element, to wit the sleeve 628, surrounding one other of the elements, to wit core portion 616. The sleeve 628 is of a resiliency permitting it to undergo an expansion by the pressure exerted by the fluid, such expansion being instrumental in opening the mouth M.

The embodiment illustrated in Fig. 7 is similar to that shown in Figs. 6 and 8 differing therefrom by the shape of the lower core portion surrounded by the bushing. Beneath the peripheral groove 635 the lower core portion is frustro-conical as shown at 716 tapering in any desired direction, for instance upwardly, towards the groove 635. Accordingly, the sleeve portion 728 of the bushing 725 flares downwardly and terminates short of the front face 724 of the nozzle. The nozzle portions not shown in Fig. 7 including the central core portion 613 are similar to those shown in Fig. 6 and, therefore, need not be shown or described. Owing to the frustro-conical shape of portion 716 the jet is given a corresponding direction. Moreover, the conical shape has the effect that the bias of the sleeve portion 728 may be varied by relative axial displacement of the bushing 725 in the core. By suitable choice of the shape of the core portion and of the disposition of the end of the sleeve relative to the front face 624 or 724 of the core, the geometrical shape of the issuing jet may be influenced within wide limits. Where the fuel is issued but for a very brief instance, the jet may take the shape of a small ring having the tendency of retaining its diameter or of increasing or reducing its diameter depending on the shape of the core portion. It is also possible to give the jet the shape of a hollow cylinder of any desired length or of a frustro-cone having an annular cross section and tending, depending on the resistance of the medium into which the fuel is injected, to increase or reduce its diameter.

If desired, at least one of the elements of which the nozzle is composed may have an extension projecting forwardly from the mouth M to influence the direction of the jet. That is illustrated in Fig. 9 where the core portion 916 surrounded by the sleeve 928 is integral with a frustro-conical projection 941 which at its upper end has a smaller diameter than the annular mouth M of the nozzle, the diameter increasing downwardly beyond that of the mouth M. The other elements of the nozzle not shown in Fig. 9 are similar to those described hereinabove with reference to Figs. 6 or 7. As the fuel issuing from the mouth M impinges upon the projection 941 an additional effect is produced on the final shape of the jet. The projection 941, however, need not be frustro-conical as shown, but may have any other desired axial and transverse profile depending on the desired shape of the jet.

The cores of the nozzles described with reference to Figs. 1 to 5 may be produced in any desired manner, for instance starting from a blank having the approximate outlines of the final core portion and the transverse bore 18 by first splitting the core portion by a sawing operation and by subsequently forging or pressing the core portion in such a manner as to close the gap formed by the sawing operation. Alternatively, the core may be composed of a pair of separate members, one forming the one leg, such as 521, and the other one forming the other leg, such as 522, the two members having their outer ends subsequently united by welding, soldering, brazing, riveting, or any other suitable operation.

All of the embodiments described are free from elements sliding upon each other in operation and, therefore, free from friction and wear. They are capable of resisting high temperatures and are extremely simple in design and capable of being produced at low cost. While the nozzles are particularly adapted for fuel injection purposes, they are in no way limited to such use, but may be employed for numerous other purposes. By suitably chosing the dimensions of the various elements the nozzle may be so designed as to respond to any desired liquid pressure. Also the novel device may be employed as a valve which is normally closed, but will open under pressure only.

While the invention has been described in connection with a number of preferred embodiments thereof, it will be understood that it is capable of further modification, and this application is intended to cover any variations, uses, or adaptations of the invention following, in general, the principles of the invention and including such departures from the present disclosure as come within known or customary practice in the art to which the invention pertains, and as fall within the scope of the invention or the limits of the appended claims.

What I claim is:

1. A nozzle comprising a member having a side surface forming a surface of revolution and having a front end and a rear end, said member being provided with a crevice extending transversely of said side surface from a point intermediate the front and rear end thereof

forwardly up to said front end to thereby leave an integral portion near the rear end and a divided portion near the front end thereof, means for admitting fluid under pressure to said crevice including a bore extending transversely to said side surface of revolution adjacent said point and with said crevice terminating rearwardly at said transverse bore, the divided forward portion of said member thereby constituting leg portions formed of yieldable material and thickness so as to yield under the pressure exerted by said fluid to widen said crevice and to issue a jet from said front end, and a sleeve closely surrounding said member in permanent sealing contact with said side surface of revolution at least over a substantial part of said side surface adjacent said front end to thereby provide at all times a fluid tight seal thereat between said surface and said sleeve over the entire circumference of said side surface, said sleeve being formed of such material and thickness as to participate in the yielding of said leg portions.

2. A nozzle as claimed in claim 1 in which said crevice extends in axial direction with respect to said surface of revolution.

3. A nozzle as claimed in claim 1 in which said crevice at least near the mouth thereof extends at an angle to the axis of said surface of revolution.

4. The combination as claimed in claim 1 in which said sleeve extends to said front end.

5. A nozzle comprising an integral member having a

side surface, the same being a surface of revolution, and having a front end and being provided with a crevice formed by plane faces extending axially to said front end, said plane faces comprising relatively angularly disposed sections all of which are spaced from and extend parallel to the axis of said member and comprise a central section joining parallel sections extending parallel to each other and being of equal length and terminating in end sections which extend outwardly up to the side surface of said member parallel to said central section, a sleeve closely surrounding said member in contact with said surface of revolution and laterally closing said crevice, and means to admit a fluid under pressure to said crevice at a point spaced from said front end, said member and said sleeve being of a resiliency permitting the pressure exerted by said fluid to widen said crevice and to issue from said front end in a jet.

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