United States Patent [19]

Greathouse

[11] **3,777,984**

[45] **Dec. 11, 1973**

[54] **MINIATURE FUEL INJECTION NOZZLE AND HOLDER ASSEMBLY**

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[73] Assignee: **Mack Trucks, Inc.,** Allentown, Pa.

[22] Filed: **Jan. 20, 1972**

[21] Appl. No.: **219,347**

[52] **U.S. Cl.** **239/533,** 239/584

[51] **Int. Cl.** **F02m 47/00**

[58] **Field of Search** 239/533, 600, 453, 239/584, 585, 87

[56] **References Cited**

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3,486,696	12/1969	Dreisin	239/533
3,511,442	5/1970	De Luca et al.	239/533
3,511,443	5/1970	Glikin et al.	239/533
3,620,456	11/1971	Berg	239/533

FOREIGN PATENTS OR APPLICATIONS

8,714	10/1913	Great Britain	239/87

Primary Examiner—M. Henson Wood, Jr.
Assistant Examiner—Andres Kashnikow
Attorney—Granville M. Brumbaugh et al.

[57] **ABSTRACT**

A miniature fuel injection nozzle and holder assembly for internal combustion engines includes a holder body formed with a transverse slot or slots in which two or more parallel compression springs are symmetrically disposed about the axis of the nozzle valve, upon which they act. The springs are insertable into and removable from the holder body through its side by means of the slots. Interchangeable spring guides may be employed to receive adjacent ends of the springs for alignment and transmission of their compressive forces to the nozzle valve. In one embodiment, access for adjustment of the compression of the springs, and thus the valve opening pressure, may be had through the transverse slots.

23 Claims, 9 Drawing Figures

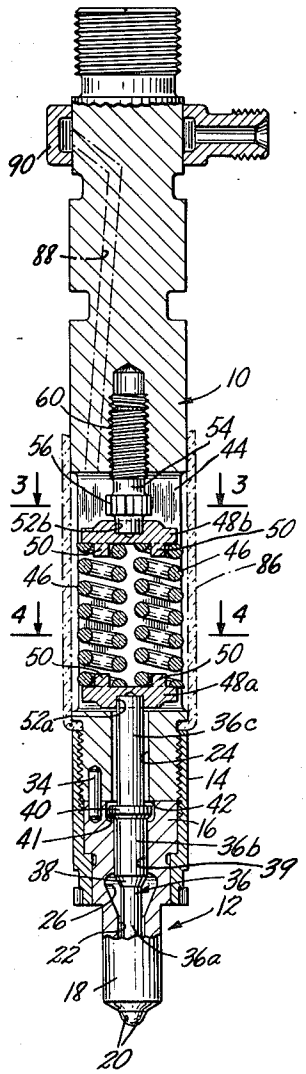


FIG. 1

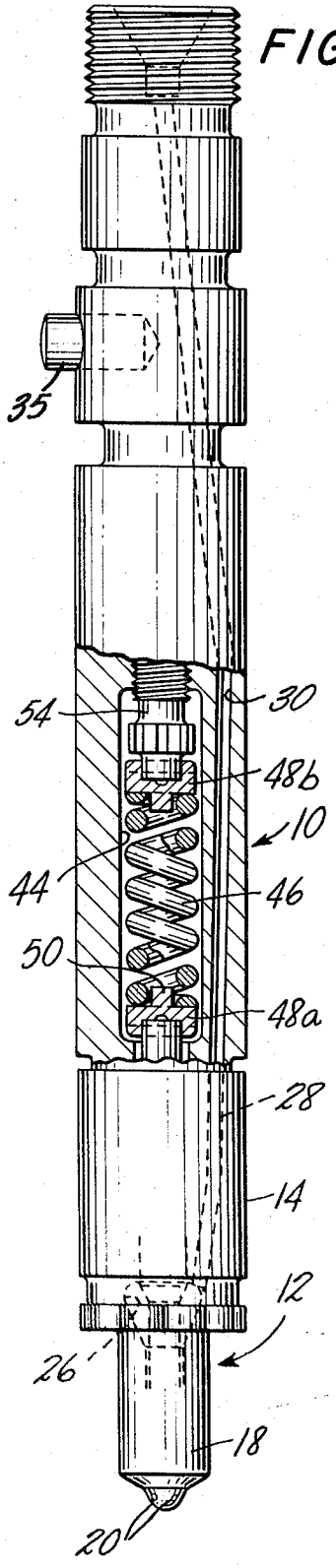


FIG. 2

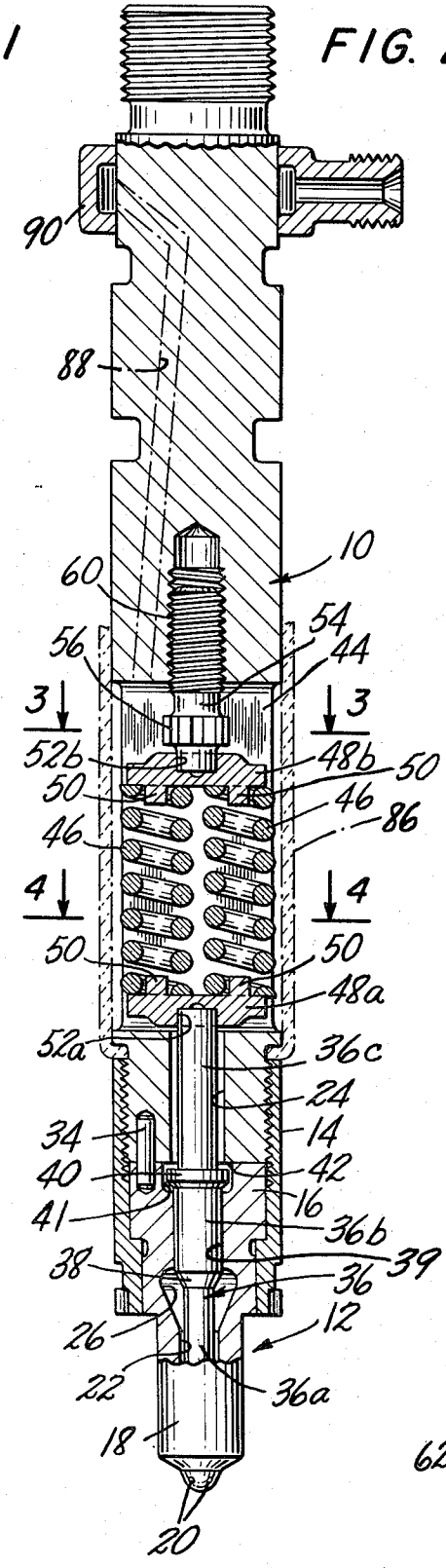


FIG. 3

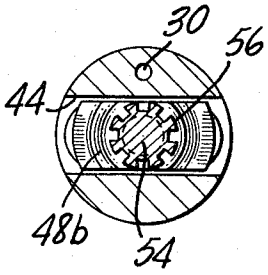


FIG. 4

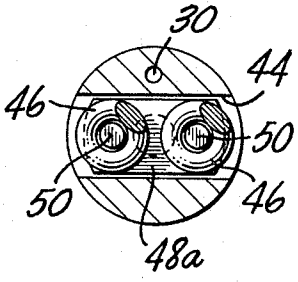


FIG. 5

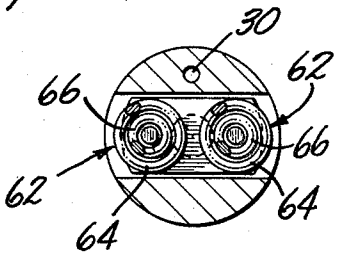


FIG. 6

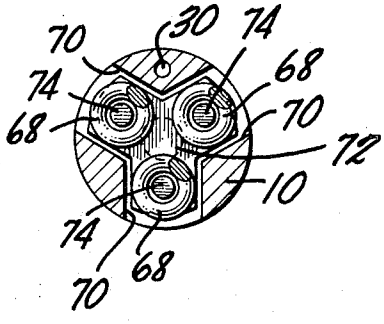


FIG. 7

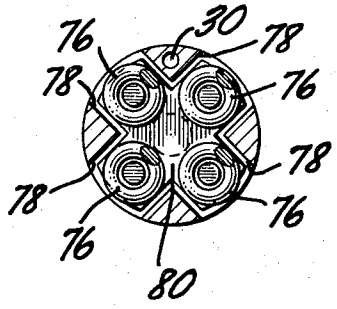


FIG. 9

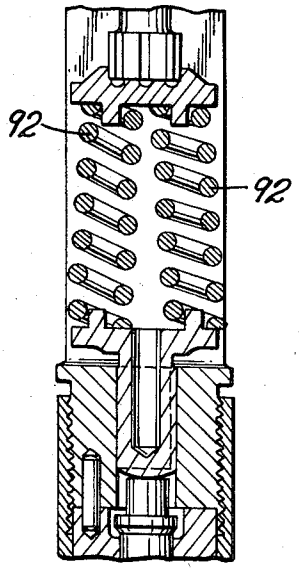
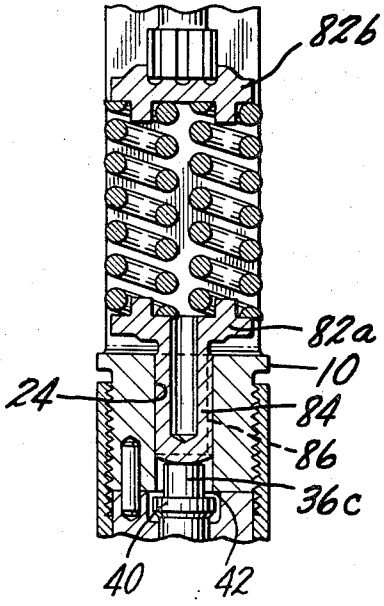


FIG. 8



MINIATURE FUEL INJECTION NOZZLE AND HOLDER ASSEMBLY

BACKGROUND OF THE INVENTION

This invention relates generally to fuel injection devices for internal combustion engines and particularly concerns miniature fuel injection nozzle and holder assemblies for such engines.

Recent improvements in the performance of fuel injection engines within established cylinder sizes have necessitated the use of a larger proportion of the engine space for valve porting and cooling. The space available for such purposes, however, is restricted by the bulk of the fuel injection nozzle and holder assemblies, and their associated structural envelopes, now in use. This problem is particularly marked where the assembly lies between adjacent valve ports. It is also especially significant in compact diesel engines, such as those proposed for automotive use. Reduction of the size of the nozzle and holder assembly is therefore needed and would constitute an important advance in engine design.

The higher rates of fuel injection and higher engine speeds currently utilized further emphasize the need for size reductions in these assemblies and most notably in the mass of the nozzle valve and its associated moving parts. Prior practice in this regard has been to position the valve loading spring centrally or nearly centrally within the holder body directly above the nozzle valve in order to shorten the assembly and reduce the mass of the valve components. Conventionally, the pocket or recess for the valve spring opens through the interface or interfaces between the holder body and the nozzle body. The requisite fuel supply ducts, cooling ducts and indexing pins, which also extend through the interface, are then positioned outwardly of the spring pocket.

This construction, though advantageous in certain respects, has had a limiting effect on the extent to which nozzle and holder assemblies may be safely reduced in size for given fuel delivery requirements. Size reduction in general, and of the assembly diamter in particular, has been precluded heretofore chiefly because relatively large diameter springs were needed to provide the valve biasing force necessary to proper fuel injection performance under typical peak combustion pressures. As large springs in turn require large recesses or pockets in the holder body, the cross-sectional area of the assembly could not be reduced by any measurable amount, particularly at the nozzle body-holder body interface, and still provide sufficient material for locating the fuel ducts, indexing pins and the like in the vicinity of the spring pocket while at the same time affording an assembly of adequate structural rigidity.

In previously known devices of this kind, it is also common practice to interpose a sandwich type stop plate between the nozzle body and the holder body to limit or control the maximum valve lift. Such a plate increases the cost of the assembly and, as the indexing pins and fuel ducts extend therethrough, detracts from its reliability by introducing a potential source of fuel leakage at the interfaces under high pressure.

A more recent development along these lines is disclosed in U.S. Pat. No. 3,620,456 to Berg. There, a plurality of springs arranged in parallel act on the nozzle valve through a single spring guide. The springs, however, are located within a separate spring housing which is itself contained within the nozzle holder. This arrangement requires that the spring pockets open through an end of the spring housing, the holder body-spring housing interface in the embodiment disclosed, and additionally necessitates the provision of a fuel duct or ducts in the spring housing as well as in the holder body and the nozzle body. Furthermore, the device must be disassembled before any adjustment of the valve opening pressure can be made.

These and other disadvantages of prior art fuel injection devices are overcome by the present invention.

SUMMARY OF THE INVENTION

In accordance with the invention, a miniature fuel injection nozzle and holder assembly of reduced diameter is provided which includes a holder body and a nozzle body held together in axial alignment, a reciprocative nozzle valve within the holder and nozzle bodies and openable in response to the fuel pressure within the nozzle body, at least one transverse slot in the holder body axially aligned with the valve and two or more compression springs positioned within the slot in parallel or symmetrically sloping relation for biasing the valve to a normally closed position. The transverse slot opens at least at one end through the side of the holder body and is of a size to permit the compression springs to be installed through the side opening. A plurality of such slots, each containing a spring arranged in parallel to each other spring, may be provided. If so, they preferably are symmetrically located about the nozzle valve axis.

In this way, not only is an increased valve loading force developed without necessitating larger diameter springs, but a spring pocket opening through the holder body-nozzle body interface is entirely eliminated. This leaves a greater cross-sectional area available at the interface for fuel ducts, indexing pins, etc., and eliminates the need for the intermediate stop plate typically found in prior art devices. Further, it simplifies construction and assembly of the nozzle and holder unit avoiding, for example, any need for a separate spring housing portion in addition to the holder body. A single guide or guides, common to all of the springs of the spring set, maintains the springs in position and transmits their compressive force to the nozzle valve. In one form, the guides are interchangeable, having substantially identical configurations. Where plural symmetrical slots are employed, the guides desirably are shaped to correspond to the internal configuration of the slotted holder body.

Provision is also made for regulating the compression of the springs, and hence of the opening or popping pressure of the valve. This may be accomplished by means of shims, wedges or the like or an adjusting screw may be provided. Access to the adjusting structure is preferably through the side opening of a transverse slot, thus permitting adjustment to be carried out without necessitating disassembly of the device.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing and additional advantages and objects of the invention will be more readily apparent from the following description of an exemplary embodiment, taken in conjunction with the figures of the accompanying drawings, in which:

FIG. 1 is a side elevational view, partly in section, of a fuel injection nozzle and holder assembly constructed in accordance with the invention;

FIG. 2 is a partial sectional view of the nozzle and holder assembly of FIG. 1 taken at a 90° angle to the plane of FIG. 1;

FIG. 3 is horizontal sectional view taken along the line 3—3 of FIG. 2 and looking in the direction of the arrows;

FIG. 4 is a horizontal sectional view taken along the line 4—4 of FIG. 2 and looking in the direction of the arrows;

FIG. 5 is a horizontal sectional view of an alternative embodiment of the invention, depicting the use of parallel concentric sets of valve loading springs;

FIGS. 6 and 7 are horizontal sectional views of still other embodiments of the invention;

FIG. 8 is a partial vertical sectional view showing another form of spring guide for loading the nozzle valve; and

FIG. 9 is a partial vertical sectional view of an embodiment of the invention, depicting the use of symmetrically sloping valve loading springs.

DESCRIPTION OF AN EXEMPLARY EMBODIMENT

Referring in particular to FIGS. 1 and 2, a representative embodiment of a fuel injection nozzle and holder assembly includes, in accordance with the invention, a generally cylindrical shaped holder body **10** and nozzle body **12** of like shape that are secured together in axial alignment by a cap nut **14.** The nozzle body **12** is generally conventional, having a body portion **16** and a nose portion or tip **18** formed at the end with a plurality of fuel discharge orifices **20.** It also includes a central bore **22** which, when the nozzle and holder bodies are assembled, is axially aligned with a central passage **24** formed in the mating end of the holder body **10.** The nozzle bore **22** is enlarged at an intermediate location into an annular chamber **26** for receiving high pressure fuel, such fuel being supplied to the chamber **26** through communicating passages or ducts **28** and **30** in the nozzle body **12** and holder body **10,** respectively.

Proper alignment of the ducts **28** and **30** relative to each other may be had through the use of indexing pins **34** extending across the nozzle-holder interface. An exterior pin or pins **35** (see FIG. 1) may also be provided to control the orientation of the discharge orifices **20** or the discharge orifice cone angles relative to physical features within the combustion chamber, if the engine design requires such orientation control.

A pintle or needle valve **36,** i.e., the nozzle valve, (see FIG. 2) is received within the bore **22** and passage **24** for reciprocating movement therein. At its discharge end, the valve **36** terminates in a valve seat (not shown) which cooperates with a correspondingly shaped valve seat (not shown) in the bore **22** of the nozzle.

In the embodiment disclosed in FIGS. **1** and **2,** the pintle valve **36** includes three distinct portions. The lowermost portion **36*a*** extends from the aforementioned valve seat forwardly to the region of the annular chamber **26,** where it is joined by a shoulder **38** to a portion **36*b*** of enlarged diameter. The diameter of the enlarged portion **36*b*** is such that it forms a relatively close tolerance fit within a second bore **39** in the nozzle body. Ample clearance is provided, on the other hand, between the valve portion **36*a*** and the bore **22** for fuel flow from the chamber **26** to the discharge orifices **20.** Alternatively, a close tolerance fit could be used here as well, with the valve portion **36*a*** being slotted to allow fuel flow.

The third valve portion **36*c*** lies primarily within the holder passage **24** and conveniently may be smaller in diameter than valve portion **36*b***. A clearance is also provided between the passage **24** and the valve portion **36*c*** to facilitate assembly and to allow withdrawal through the passage **24** of any fuel which has leaked upwardly along the valve member from the chamber **26.** Between portions **36*b*** and **36*c***, the pintle valve is formed with a projection **40** that is adapted to abut against the end surface **42** of the holder body **10** and thus limit the maximum lift of the valve **36** during fuel injection operation. An appropriately shaped recess **41** formed in the facing end of the nozzle body **12** accommodates the projection **40.** This represents a substantial design simplification relative to conventional practice, which as noted typically employs a separate stop plate interposed between the nozzle and holder bodies. Such plates add to fabrication and assembly costs as well as detracting from the performance reliability of the unit by introducing a potential source of leakage of the high pressure fuel.

The pintle valve **36** is caused to be retracted to the open position by the action of the high pressure fuel against the shoulder **38** and other exposed surfaces of the valve when the fuel is admitted to the chamber **26.** It is normally biased to the closed position by the action of compression springs, as hereinafter described, located within the holder body **10.**

Turning now to the holder **10,** it is a feature of the invention that the coaxial or nearly coaxial spring pocket conventionally opening through the nozzle body-holder body interface is eliminated by the present invention without requiring the use of a separate spring housing. Instead, one or more transverse slots **44** are formed in the holder in alignment with the pintle valve **36.** Only one such slot is illustrated in the embodiment of FIGS. **1** to **4.** Conveniently, the slot **44** extends completely through the holder body **10** so as to open to both sides of the holder, as depicted in FIGS. **2, 3** and **4.** If desired, however, the slot need extend only partially through the holder, with only one end opening through the holder side. The slot **44** is intended to receive two or more compression springs **46** in parallel or symmetrically sloping side-by-side relation, and it is dimensioned accordingly. The springs **46** are held in position within the slot **44** and in force transmitting relation to the pintle valve **36** by a pair of guides **48*a*** and **48*b***.

According to another feature of the invention, the guides **48*a*** and **48*b*** may be of substantially identical configuration and therefore interchangeable in position. With this construction of the guides, there is less likelihood of improper assembly of the unit, and the number of parts required to be inventoried is reduced. Referring now to FIGS. **2** and **4** in particular, each guide includes a pair of spaced pilots **50** that fit within the ends of the springs **46** and retain the spring axes generally in parallel with the axis of the pintle valve **36.** If space permits, recesses (not shown) could be used in place of the pilots **50.** In either event, the valve is loaded by both springs in the axial direction. To that end, the free end of the upper valve portion **36*c*** is received within a recess **52*a*** formed in the facing side of

the guide 48*a*. A like recess 52*b* is also formed in the upper guide 48*b* and receives one end of an adjustment screw 54. In keeping with the interchangeable nature of the guides 48*a* and 48*b*, the recesses 52*a* and 52*b* are of substantially the same diameter and depth, and the corresponding ends of the pintle valve 36 and the adjustment screw 54 are similarly sized.

Manipulation of the adjustment screw 54 permits ready calibration or regulation of the compression of the springs 46 and, hence, of the opening or popping pressure of the pintle valve 36. To facilitate such adjustment, the screw 54 is provided with teeth 56 (see FIGS. 2 and 3) or like means that are adapted to cooperate with a suitably shaped tool. Also, self-locking threads 60 or other functionally equivalent structure may be provided so that the screw 54 will automatically retain the springs 46 at the compression loading selected.

A significant advantage of this adjustment feature is that the screw 54 is accessible for manipulation through the open end or ends of the transverse slot 44. Because of this accessibility, the pintle valve opening pressure may be adjusted to the desired magnitude while the nozzle and holder unit is coupled to pressure test equipment without necessitating disassembly of the unit or its disconnection from the test equipment. This is of particular practical value inasmuch as disassembly or disconnection of the nozzle and holder assembly is a rather laborious procedure, involving very small component parts, and entails a risk of improper assembly.

It will be appreciated, of course, that other means may be employed to adjust the compression of the springs. For example, a shim-pack, wedges, cam mechanism, etc., could be used for this purpose. Similarly, the adjustment need not be effected through the slot ends, and indeed the adjustment device or structure need not be located within the slot itself. As one example, an adjusting screw located exteriorly of the slot might be used.

Like benefits relative to prior art fuel injection devices result from the use of plural, parallel or symmetrically sloping springs in loading the pintle valve 36 and in the provision of the transverse slot 44 for receiving the springs. Since two (or more) compression springs are used, a higher valve loading force is developed than can be had with a conventional coaxial single spring or spring nest of equivalent diameter. Moreover, as the springs 46 of the invention are installed through the side of the holder body 10, rather than through the interface between the holder body and the nozzle body or through the end of a separate spring housing, there is no need for a large opening in the nozzle-holder interface or the holder-spring housing interface for admission of the springs. A greater cross-sectional area is therefore available at all interfaces for fuel ducting, indexing pins, and the like. This permits a reduction in the diameter of the nozzle and holder assembly while still providing an adequate net cross-sectional area to meet structural loading requirements and to satisfy machining limitations. The passage 24 in the holder body 10, for example, may be made considerably smaller than that which would be required, as in prior art devices, to allow the insertion of a compression spring of a size sufficient to provide the necessary valve loading force.

Where still greater spring force is required, as, for example, where a low injection rate but high opening pressure is needed, one or more springs could be provided in parallel in addition to the two side-by-side springs 46 illustrated in the drawing. One way in which this might be accomplished is portrayed in FIG. 5, where parallel sets 62 of springs, each set including two or more concentrically arranged springs 64 and 66, are employed.

Alternatively, additional single springs might be arranged in parallel or symmetrically sloping relationship within two, three or more slots. Thus, in FIG. 6, three parallel springs 68 are shown located within three interconnecting slots 70, each of which opens at one end through the side of the holder body 10. Preferably, both the springs 68 and the slots 70 are symmetrically arranged about the axis of the nozzle valve 36, thereby tending to load the valve evenly. A single spring guide 72, having pilots 74, retains the springs 68 generally in parallel and transmits their combined force to the valve 36.

FIG. 7 illustrates an embodiment including four springs 76 and two intersecting slots 78 that open at both ends through the sides of the holder body. Again, a single guide 80, common to all of the springs, is utilized. In both the FIG. 6 and FIG. 7 embodiments, the fuel duct 30 is formed in a region between slots in which an adequate metal cross section exists.

Preferably, the spring guides 72 and 80, and that 48*a* of FIGS. 1 to 5 as well, correspond in cross section to the internal cross section of the slotted portion of holder body 10. Guide 48*a*, therefore, has only two legs, i.e., it is generally T-shaped, while guides 72 and 80 have three and four legs respectively. As noted, this construction affords a generally symmetrical loading of the nozzle valve 36.

Turning now to FIG. 8, a further embodiment of the invention includes, instead of identical spring guides, an outer guide 82*b* of the configuration previously described in connection with the embodiment of FIGS. 1 to 4 and an inner guide 82*a* that is formed with an axial extension 84. The extension 84 is slidably received within the passage 24 of the holder body 10, where it engages in force transmitting relation the outer end of the valve portion 36*c*. In this regard, the valve portion 36*c* is shortened relative to its length in the earlier described embodiment. Leak-off of fuel is provided by an axial slot 86 in the guide extension 84.

As another alternative, extension 84, or the valve portion 36*c*, may be formed separately of the guide 82*a* or nozzle valve 36, as the case may be, and consists simply of an independent member. It may also include the projection 40 for limiting opening travel of the valve 36. FIG. 9 illustrates an embodiment discussed above that includes two symmetrically sloping springs 92 adapted to a spring guide configuration similar to that shown in FIG. 8. Symmetrically sloping spring arrangements including more than two springs are possible by arranging the springs within the desired number of interconnecting slots in a manner similar to the parallel spring arrangement shown in FIGS. 6 and 7. The latter construction would be advantageous, for example, where the end surface 42 of the holder body 10 must be maximized relative to the size of the projection 40.

Although the invention has been described with reference to specific embodiments thereof, many modifications and variations may be made to one or all of those embodiments by one skilled in the art without departing from the inventive concepts disclosed. For ex-

ample, the nozzle and holder assembly portrayed in the drawings is designed for engine applications where the nozzle valve leak-off of fuel, i.e., fuel escaping from the chamber **26** along the pintle valve portions **36***b* and **36***c*, is drained off through the area of the engine structure surrounding the holder body **10.** Such fuel leak-off might also be confined by surrounding at least the slotted portion of the holder body with a sealed jacket **86** (see FIG. **2**) and ducted off through the upper part of the holder body **10** by means of a duct **88** leading to a fitting **90.** All such variations and modifications, therefore, are intended to be included within the spirit and scope of the appended claims.

I claim:

1. A fuel injection nozzle and holder assembly for internal combustion engines comprising:

an elongate nozzle body having an axially extending bore formed therein;

an elongate holder body having an axially extending passage formed therein;

means securing the holder body and the nozzle body together with the bore and the passage in generally axial alignment;

an elongate reciprocative valve member disposed in the bore and openable in response to the fuel pressure within the nozzle body;

means defining at least one transversely extending, axially elongated slot in the holder body, the slot communicating at one side with the axially extending passage and opening at least at one end through the side of the holder body;

means, including at least two compression springs positioned within the slot, acting through the axially extending passage for biasing the valve member to a normally closed position; and

means defining fuel supply ducts in the holder body and the nozzle body for supplying pressurized fuel to the nozzle body for opening of the valve member and subsequent injection into the engine.

2. A fuel injection nozzle and holder assembly according to claim **1** wherein the valve member biasing means further includes means for controlling the compression of the springs so as to permit adjustment of the opening pressure of the valve member.

3. A fuel injection nozzle and holder assembly according to claim **2** wherein the opening pressure adjusting means comprises adjusting screw means located within the slot and accessible for adjustment through the open end thereof.

4. A fuel injection nozzle and holder assembly according to claim **1** wherein:

the valve member biasing means further includes common guides for receiving the opposite ends of the compression springs; and

the valve member includes a portion extending into the transverse slot through the axially extending passage, the adjacent spring guide being in force transmitting engagement with the extended portion of the valve member.

5. A fuel injection nozzle and holder assembly according to claim **4** wherein the common guides are interchangeable in position and are of substantially identical construction.

6. A fuel injection nozzle and holder assembly according to claim **4** further comprising means formed on the valve member and the holder body for limiting the opening travel of the valve member.

7. A fuel injection nozzle and holder assembly according to claim **1** wherein the valve member biasing means includes at least two sets of concentric springs.

8. A fuel injection nozzle and holder assembly according to claim **1** wherein:

the valve member biasing means includes a guide for receiving the ends of the compression springs adjacent to the nozzle body; and

the guide includes an elongate portion positioned within the axially extending passage in force transmitting engagement with the valve member.

9. A fuel injection nozzle and holder assembly according to claim **8** further comprising means formed in part on the holder body for limiting the opening travel of the valve member.

10. A fuel injection nozzle and holder assembly according to claim **1** wherein the compression springs are positioned in parallel relation.

11. A fuel injection nozzle and holder assembly according to claim **1** wherein the compression springs are positioned in symmetrically sloping relation.

12. A fuel injection nozzle and holder assembly according to claim **1** further comprising:

means for enclosing at least the slotted portion of the holder body to prevent fuel leakage through the slot open end; and

means, including a duct formed in the holder body and communicating with the transverse slot, for leaking off fuel escaping to the transverse slot through the axially extending passage.

13. A fuel injection nozzle and holder assembly for internal combustion engines comprising:

an elongate nozzle body having an axially extending bore formed therein;

an elongate holder body having an axially extending passage formed therein;

means securing the holder body and the nozzle body together with the bore and the passage in generally axial alignment;

an elongate reciprocative valve member disposed in the bore and openable in response to the fuel pressure within the nozzle body;

means defining a plurality of interconnecting transverse slots symmetrically arranged relative to the axially extending passage in the holder body, each slot communicating at one side with the axially extending passage and opening at least at one end through the side of the holder body;

means, including at least one compression spring positioned within each slot, acting through the axially extending passage for biasing the valve member to a normally closed position; and

means defining fuel supply ducts in the holder body and the nozzle body for supplying pressurized fuel to the nozzle body for opening of the valve member and subsequent injection into the engine.

14. A fuel injection nozzle and holder assembly according to claim **13** wherein the springs are arranged symmetrically about the axis of the valve member.

15. A fuel injection nozzle and holder assembly according to claim **13** wherein the valve member biasing means includes a common guide for receiving the ends of the compression springs adjacent to the nozzle body, the guide being shaped in cross section to correspond to the internal cross section of the holder body.

16. A fuel injection nozzle and holder assembly according to claim **13** wherein the valve member biasing

means further includes means for controlling the compression of the springs so as to permit adjustment of the opening pressure of the valve member.

17. A fuel injection nozzle and holder assembly according to claim **13** wherein:

the valve member biasing means further includes common guides for receiving the opposite ends of the compression springs; and

the valve member includes a portion extending into the transverse slot through the axially extending passage, the adjacent spring guide being in force transmitting engagement with the extended portion of the valve member.

18. A fuel injection nozzle and holder assembly according to claim **17** further comprising means formed on the valve member and the holder body for limiting the opening travel of the valve member.

19. A fuel injection nozzle and holder assembly according to claim **13** wherein:

the valve member biasing means includes a guide for receiving the ends of the compression springs adjacent to the nozzle body; and

the guide includes an elongate portion positioned within the axially extending passage in force transmitting engagement with the valve member.

20. A fuel injection nozzle and holder assembly according to claim **19** further comprising means formed in part on the holder body for limiting the opening travel of the valve member.

21. A fuel injection nozzle and holder assembly according to claim **13** further comprising:

means for enclosing at least the slotted portion of the holder body to prevent fuel leakage through the open ends of the slots; and

means, including a duct formed in the holder body and communicating with the transverse slots, for leaking off fuel escaping to the slots through the axially extending passage.

22. A fuel injection nozzle and holder assembly according to claim **13** wherein the springs in the respective slots are positioned in parallel relation to each other spring.

23. A fuel injection nozzle and holder assembly according to claim **13** wherein the springs in the respective slots are positioned in symmetrically sloping relation to each other spring.

* * * * *

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,777,984 Dated December 11, 1973

Inventor(s) JACK F. GREATHOUSE

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 1, line 42, "diamter" should read --diameter--;

Column 6, lines 53 through 60, beginning at "Fig. 9" and ending with "shown in Figs. 6 and 7" should appear as a new paragraph following line 63.

Signed and sealed this 23rd day of April 1974.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents