United States Patent

[11] 3,598,314

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[21] Appl. No. 7,200
[22] Filed Jan. 30, 1970
[45] Patented Aug. 10, 1971

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Continuation of application Ser. No. 680,824, Nov. 6, 1967, now abandoned.

[54] ACCUMULATOR-TYPE INJECTION VALVE

19 Claims, 2 Drawing Figs.

[52] U.S. Cl. 239/96, 239/533
[51] Int. Cl. F02m 41/16
[50] Field of Search 239/81, 86, 88, 89, 91, 96, 553; 137/513, 513.3, 513.7, 596.13; 222/518

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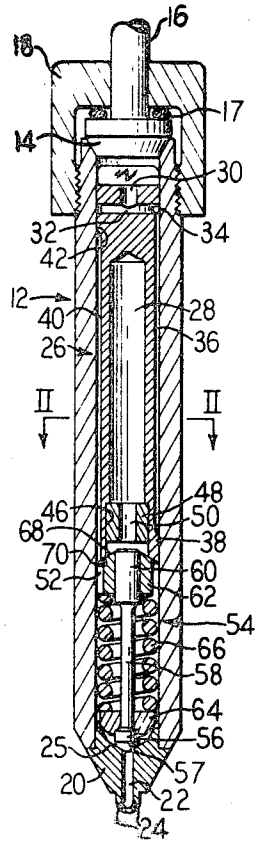
ABSTRACT: An accumulator-type injector nozzle providing a case defining a valve chamber, an inwardly opening spring-loaded check valve being positioned within the chamber for controlling a fuel outlet, a sleeve defining a fuel accumulator chamber being positioned within the case to receive pressurized fuel having leaked behind the check valve, the sleeve also serving as an edge-type fuel filter, the sleeve further serving to align the check valve with the outlet and to adjust the load on the valve spring.



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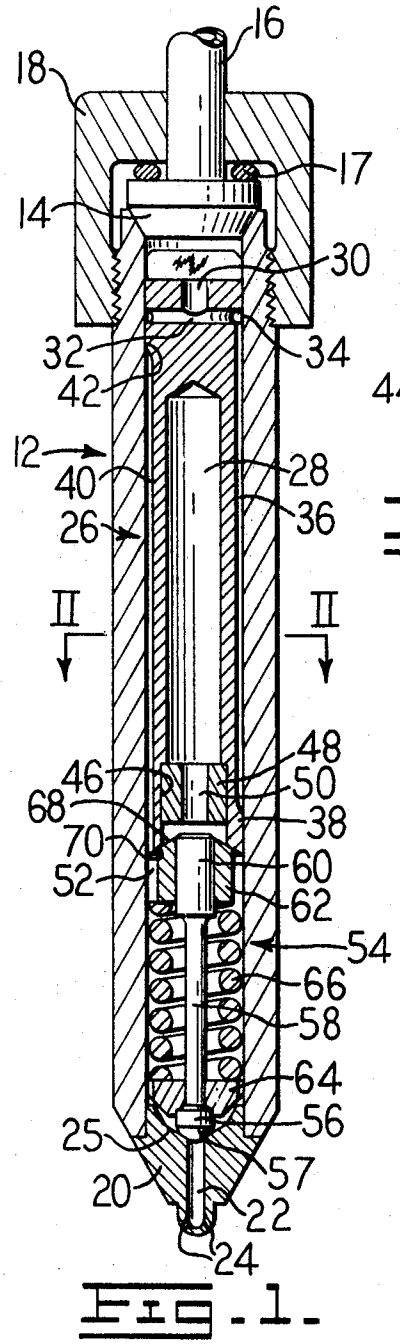

Fig. 1.

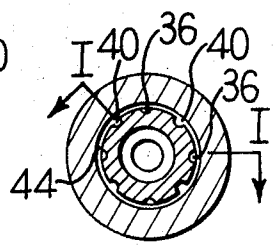

Fig. 2.

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ACCUMULATOR-TYPE INJECTION VALVE

This application is a continuation of Ser. No. 680,824, now abandoned.

Fuel injection valves and nozzles are employed in internal combustion engines for atomization of the fuel and delivery of timed injections of the latter as a spray into the engine cylinders. The known fuel injection valves are of either the outwardly opening or the inwardly opening type. The inwardly opening valves, while offering potentially good engine starting, fuel economy and performance, have heretofore presented a number of disadvantages. Such valves have been of complex design, being constructed of a great number of component parts, and being difficult and costly to manufacture.

An inwardly opening valve has usually required the use of a fuel leakoff line for the removable of fuel having leaked between the valve parts, which leakoff line adds to the cost of the valve, and also complicates the valve installation procedure. As a further disadvantage, and resulting particularly from the close clearances required in their manufacture, the inwardly opening valves are often susceptible to sticking during their operation.

The present invention is designed to overcome the disadvantages of the inwardly opening fuel injection valves of the prior art. The objects and advantages of the invention will become apparent to one skilled in the art, from the following description, when read in conjunction with the accompanying drawings, in which:

FIG. 1 is a longitudinal sectional view taken through a valve constructed in accordance with the invention, and along the line I–I of FIG. 2; and

FIG. 2 is a transverse sectional view, taken along the lines II–II of FIG. 1.

In FIG. 1, there is shown an inwardly opening fuel injection valve constructed in accordance with the invention. The valve provides a generally cylindrical case 12 closed at its upper end by a sealing member 14 which carries a fuel intake line 16, the sealing member being maintained in position by a washer 17 and a nut 18 threadably attached to the case 12. Secured to the case 12 at its lower end, such as by swagging, is an injector tip 20 formed with an axial outlet passageway 22 communicating with a plurality of orifices 24, a valve seat 25 being provided at the inner end of the passageway 22.

Mounted within the case 12 is a sleeve 26 which defines a fuel accumulator chamber 28. The sleeve 26 at its upper end is positioned adjacent the sealing member 14, and provides an axial passageway 30 opening into transverse passageway 32, the latter being in communication with an annular groove 34. The groove 34 communicates with a plurality of longitudinally extending grooves 36 (see also FIG. 2) formed in the sleeve outer surface, each groove 36 being closed at its lower end by a land 38 contacting the inner surface of the case 12. The outer surface of the sleeve 26 is also formed with a plurality of longitudinally extending grooves 40, each positioned intermediate two of the grooves 36, and each being closed at its upper end by a land 42 contacting the inner surface of the case 12. Since the grooves 36 are open at their upper ends and the grooves 40 are open only at their lower ends, fluid passing the sleeve 26 must flow from one set of grooves to the other through a space 44 (See FIG. 2) between the case 12 and the sleeve 26, and this space is so small that the arrangement described acts as a filter.

The sleeve 26 provides at its lower end a counterbore 46, within which is positioned a stop member 48 formed with an axial passageway 50. A valve chamber 52 is defined by the case 12, intermediate the lower end of the sleeve 26 and the injector tip 20. Located within the valve chamber 52 is a check valve 54 having a valve head 56 seated at the undersurface 57 thereof within the seat 25. The valve head 56 is secured to a stem 58, having an enlarged upper end portion 60 which has a loose sliding fit within a mounting collar 62. A

spring retainer 64 is mounted on the stem 58 adjacent the head 56, a spring 66 being positioned between the collar 62 and the retainer 64. The collar 62 is formed with an outer end spherical face 68 which bears against a conical inner end abutment surface 70 of the sleeve 26, the surface 70 being coaxial with the passageway 22.

During assembly of the valve 10, the abutment surface 70 of the sleeve 26 is brought into contact with the spherical face 68 of the collar 62 for correct alignment of the valve 54, and for compression of the spring 66 to an extent necessary to maintain a predetermined pressure on the retainer 64 and valve head 56. The sleeve 26 is then fixed in position by welding, press fitting, or other suitable means.

In the operation of the valve 10, fuel from a suitable pump (not shown) is directed through the intake line 16, and flows through the passageways 30 and 32 and groove 34 into the grooves 36. The fuel flows from the grooves 36 through the filter passageways 44 for the removal of foreign material, and into the grooves 40. From the grooves 40, the fuel flows into the valve chamber 52 and exerts pressure on the exposed portion of the undersurface 57 of the valve head 56, for overcoming the force exerted by the spring 66. When the fluid pressure reaches a predetermined level, the valve head 56 moves upwardly, and the fuel flows into the passageway 22. The fluid pressure then acts upon all of the under surface 57 to produce a more rapid upward movement of the valve head 56, with a resulting "pop" action. At the same time, fuel passes through the orifices 24 and into the combustion chamber (not shown). The valve head 56 continues its upward movement until the stem portion 60 abuts the stop member 48. During such upward movement, leakage of fuel occurs between the loosely fitted stem portion 60 and the collar 62, through the passageway 50, and into the fuel accumulator chamber 28. The fuel trapped in the chamber 28 increases in pressure to an extent determined by the upward movement of the stem portion 60, the bulk modulus of the fuel, and the amount of leakage of fuel that has occurred.

When the injection of fuel is terminated, the pressure in the chamber 52 and passageway 22 decreases as a result of the escape of fuel through the orifices 24, and the reverse flow of fuel through the line 16 and back to the pump in conventional manner. When the fuel pressure has sufficiently decreased, the spring 66 urges the valve head 56 downwardly and into its seated position. Since the fuel in chamber 28 is then under comparatively great pressure, reverse leakage into the chamber 52 occurs, reducing pressure in chamber 28.

The valve provides a number of advantages as compared to the inwardly opening fuel injection valves of the prior art. The valve of the invention is of relatively simple design, and is constructed of relatively few component parts. The valve eliminates the need for a fuel leakoff line, with consequent reduction in cost and simplification of installation.

The provision of the spherical surface 68 and conical surface 70, and the relatively short guide portion 60 of the stem contribute to compactness of structure, and serve to eliminate the possibility of distortion that might cause sticking.

Various modifications can be made in the structure of the valve. If desired, the sleeve 26 might be threadably secured within the case 12, to provide for adjustability of the degree of compression of the spring 66. As another modification, the spring 66 might be constructed so that its solid height would serve as a stop, with the necessity of the stop 48 thus being eliminated. As a further modification, the tip 20 might be formed integrally with the case 12. As a still further modification, the retainer 64 might be formed integrally with the check valve 54.

We claim:

1. A fuel injection valve comprising:
   a. a case defining a valve chamber therein;
   b. inlet means adapted to communicate said valve chamber with a source of fuel;
   c. outlet means adapted to communicate said valve chamber with the exterior of said case;

d. mounting means in said chamber located intermediate said inlet means and said outlet means;
e. check valve means contained within said valve chamber intermediate said mounting means and said outlet means adapted to control the flow of fuel through said outlet means, said check valve means being mounted by said mounting means;
f. sleeve means intermediate said mounting means and said inlet means, said sleeve means being hollow so as to define
g. an accumulator chamber therein,
h. a single opening in the form of an accumulator outlet means in said sleeve means adapted to communicate the accumulator chamber with the exterior of said sleeve means, said sleeve means being otherwise free of openings communicating with said accumulator chamber; and,
i. wherein said accumulator outlet means is cooperatively positioned in sealing contact with said mounting means whereby fuel leaking between said check valve means from said valve chamber will pass into said accumulator chamber through said accumulator outlet means when fuel pressure in the valve chamber is of greater magnitude than the fuel pressure in the accumulator chamber and wherein a reverse passage of fuel from the accumulator chamber to the valve chamber will occur when fuel pressure in the valve chamber is of lesser magnitude than the fuel pressure in the accumulator chamber.

2. The invention of claim 1 wherein said outlet means include an outlet and a valve seat and said check valve means comprise a valve head adapted to mate with said valve seat and thereby sealingly close said outlet, a stem extending from said head and spring means serving to maintain said outlet normally closed when fuel pressure in the valve chamber is low.

3. The invention of claim 2 wherein said mounting means comprise a collar and said stem extends through said collar, said stem and collar being cooperatively dimensioned to provide a loose sliding fit, thereby allowing a small amount of fuel to pass therebetween.

4. The invention of claim 3 wherein said spring means comprise a spring positioned between said collar and said head.

5. The invention of claim 4 wherein said sleeve means comprise a generally cylindrical sleeve having a closed outer end and an open inner end defining said accumulator chamber, said open inner end defining said accumulator outlet means and wherein said accumulator outlet means comprise an accumulator outlet having an inner end abutment surface, said abutment surface contacting said collar for compression of said spring as well as for sealing against said collar such that said collar forms a closure for said accumulator outlet means.

6. The invention of claim 5 wherein said sleeve has mounted therein a stop member positioned to limit movement of said stem into said accumulator chamber.

7. The invention of claim 6 wherein said stop member has formed therein an axial passageway to permit leaked fuel to pass by said stop member into said accumulator chamber.

8. The invention of claim 5 wherein said sleeve has filter means thereon which cooperate with said case to provide an edge-type filter for the fuel passing into the case through said inlet means.

9. The invention of claim 8 wherein the outer surface of said sleeve contacts the inner surface of said case and wherein the filter means comprise a first and a second set of longitudinally extending grooves formed on the outer surface of said sleeve, said first set of grooves extending from said outer end only part way along the outer sleeve surface, said second set of grooves extending from said inner end only part way along the outer sleeve surface such that fuel entering said case through said inlet means will flow from the first to the second set of grooves between the sleeve outer surface and the case and thence to said valve chamber and thereby filter impurities from the fuel.

10. The invention of claim 5 wherein said abutment surface is conical and wherein said collar has a spherical face contacted by said abutment surface to form a liquidtight seal.

11. A fuel injection valve comprising:
a. a case defining a valve chamber therein;
b. inlet means adapted to communicate said valve chamber with a source of fuel;
c. outlet means adapted to communicate said valve chamber with the exterior of said case;
d. mounting means in said chamber located intermediate said inlet means and said outlet means;
e. check valve means contained within said valve chamber intermediate said mounting means and said outlet means adapted to control the flow of fuel through said outlet means, said check valve means being mounted by said mounting means;
f. sleeve means intermediate said mounting means and said inlet means, said sleeve means being hollow so as to define
g. an accumulator chamber therein,
h. a single opening in the form of an accumulator outlet means in said sleeve means adapted to communicate the accumulator chamber with the exterior of said sleeve means, said sleeve means being otherwise free of openings communicating with said accumulator chamber;
i. said accumulator outlet means being cooperatively located in contact with said mounting means; and
j. leak passage means in said mounting means adapted to restrictively intercommunicate said accumulator chamber with said valve chamber by way of said accumulator outlet means, whereby leakage of fuel from said valve chamber to said accumulator chamber will occur when fuel pressure in said accumulator chamber is less than that in said valve chamber, and a reverse leakage of fuel from said accumulator chamber to said valve chamber will occur when fuel pressure in said accumulator chamber is greater than that in the valve chamber.

12. The invention of claim 11 wherein said valve means comprise a valve having a head portion normally sealingly closing said outlet, a stem portion extending from said head portion, a spring retainer mounted on said head portion, and spring means positioned between and contacting both said means defining a passage and said spring retainer, whereby said spring means serves to maintain said head portion in its position normally sealingly closing said outlet means.

13. The invention of claim 12 wherein said spring means is a spring and wherein said stem extends through said passage in closely fitting relation therewith, and wherein said head has an exposed undersurface whereby fuel pressure in said valve chamber acting on said exposed undersurface acts to overcome the force exerted by said spring and thus move said head away from its position sealingly closing said outlet means.

14. The invention of claim 13 wherein stop means are provided within said accumulator chamber to limit travel of said stem and wherein said means defining a passage comprise a collar.

15. The invention of claim 14 wherein said means defining an accumulator chamber comprise a generally cylindrical sleeve having a closed outer end and an open inner end, said inner end defining an accumulator outlet having an inner end abutment surface, said abutment surface contacting said collar such that said collar forms a closure for said accumulator outlet means.

16. The invention of claim 15 wherein said sleeve has filter means thereon which means cooperate with said case to filter impurities from the fuel after it enters the inlet means.

17. The invention of claim 16 wherein the filter means comprise a first and a second plurality of longitudinally extending grooves on the sleeve outer surface of said sleeve, said first plurality extending from said outer end to a point adjacent the inner end, said second plurality extending from said inner end to a point adjacent the outer end, such that fuel entering said inlet will flow from said first to said second plurality of grooves

between said sleeve and said case and thence to said valve chamber and thereby filter impurities from the fuel.

18. The invention of claim 15 wherein said abutment surface is conical in shape and wherein said collar has a spherical face contacted by said abutment surface and wherein said stop means are provided with a passage to permit flow of fluid therethrough.

19. The invention of claim 11 wherein filter means are provided within the case whereby fuel entering through said inlet means will be filtered to remove impurities therefrom.