June 21, 1938. P. L. SCOTT 2,121,102

PISTON VALVE ATOMIZER

Filed Nov. 12, 1936 2 Sheets-Sheet 1

Fig. 1.

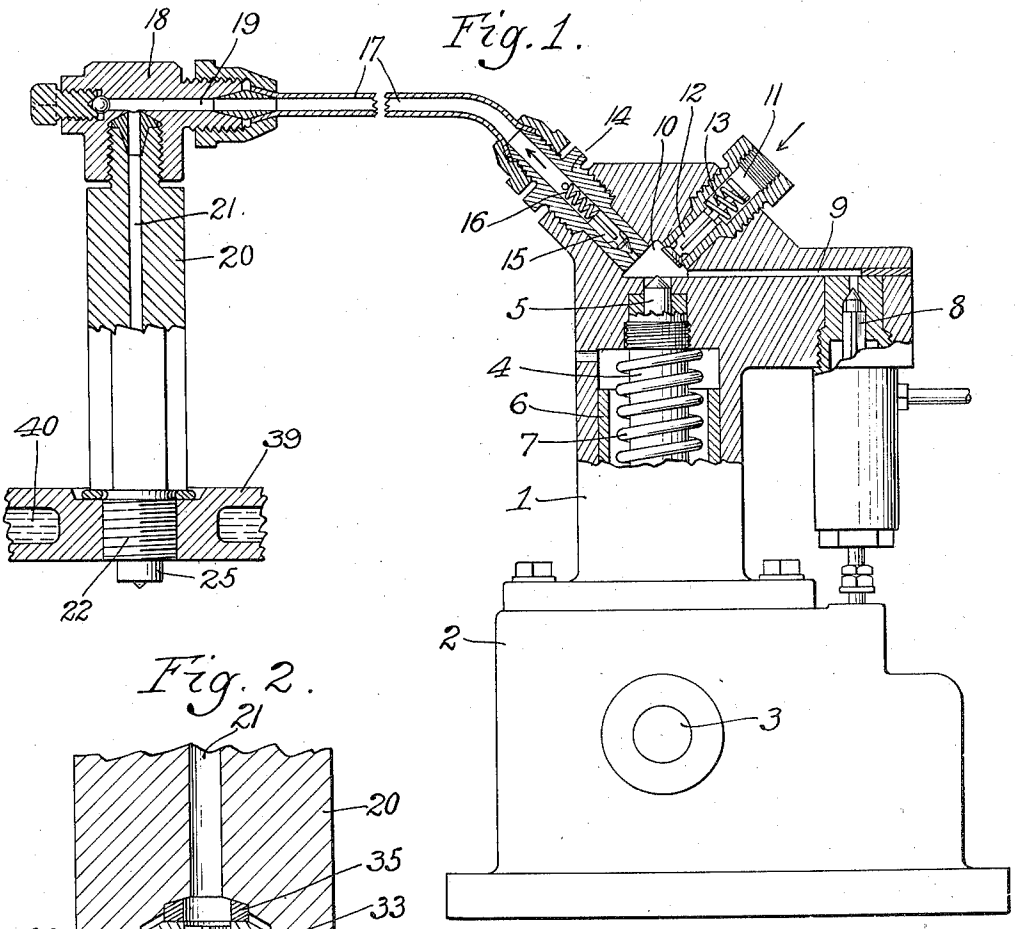
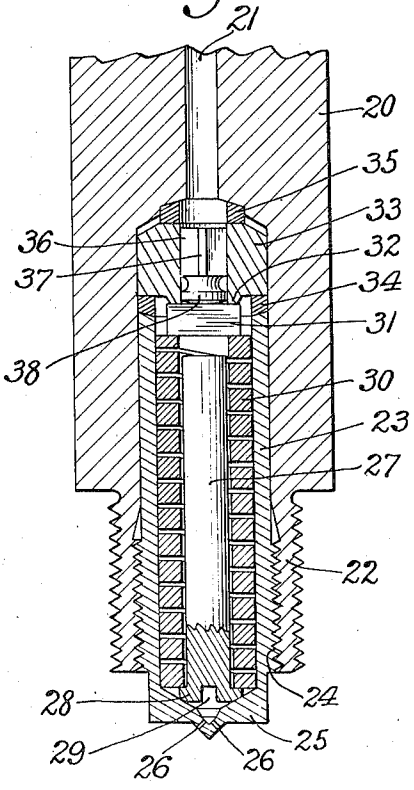


Fig. 2.



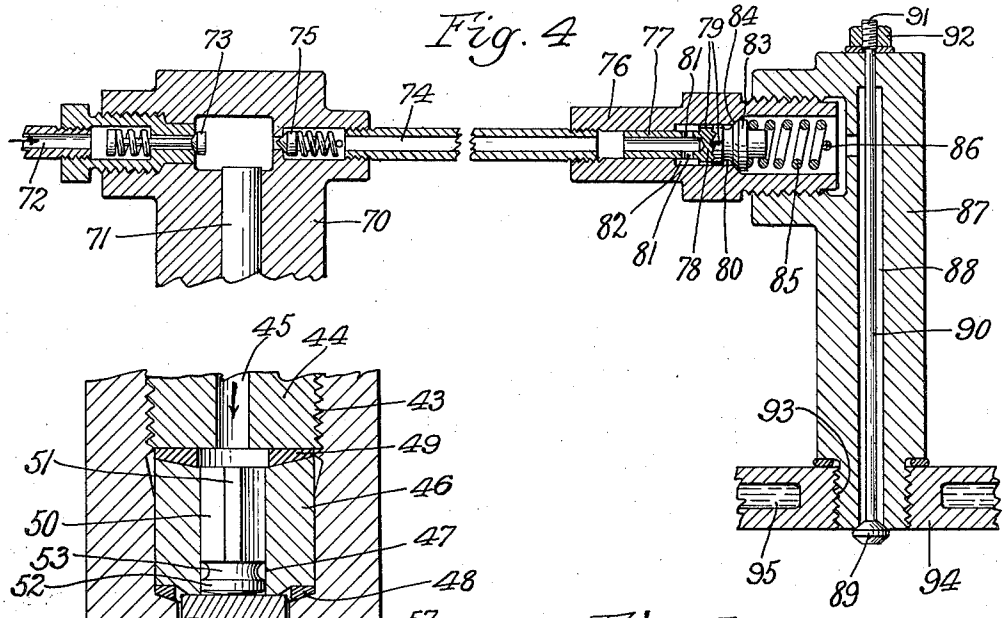
Inventor
Philip L. Scott
by Parker & Carter.
Attorneys.

June 21, 1938. P. L. SCOTT 2,121,102

PISTON VALVE ATOMIZER

Filed Nov. 12, 1936 2 Sheets-Sheet 2

Fig. 4



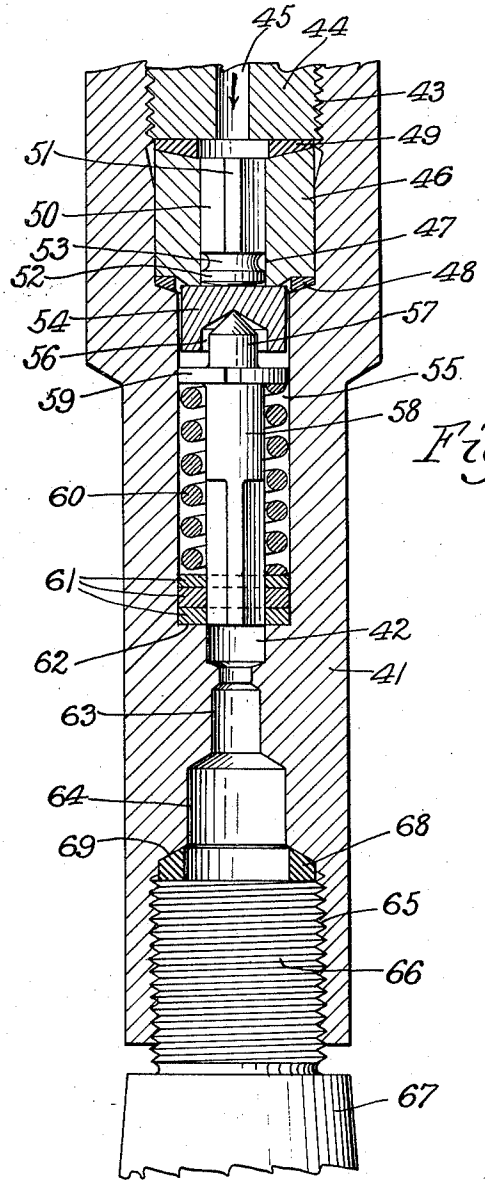
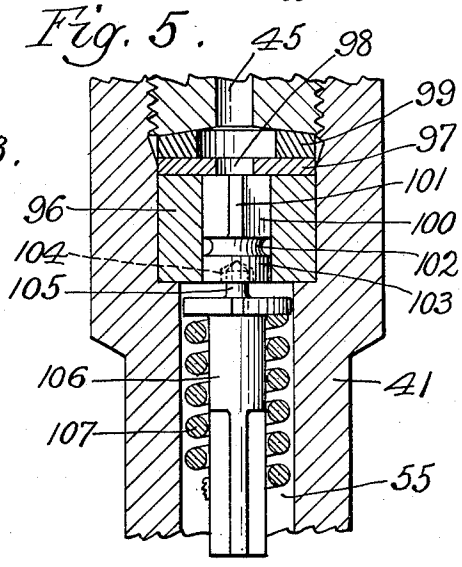


Fig. 3.

Fig. 5.



Inventor
Philip L. Scott
by Parker & Carter.
Attorneys.

Patented June 21, 1938 2,121,102

UNITED STATES PATENT OFFICE

2,121,102

PISTON VALVE ATOMIZER

Philip Lane Scott, Chicago, Ill., assignor to Super Diesel Tractor Corporation, La Porte, Ind., a corporation of New York

Application November 12, 1936, Serial No. 110,488

20 Claims. (Cl. 299—107.2)

This invention relates to an apparatus and a method for controlling pressures in the high pressure side of a pumping system and is particularly applicable in the form here shown to the control of pressures in a liquid fuel injection system of the sort which may be applied to injection internal combustion engines.

It is generally recognized that it is desirable to drop pressure in an atomizer or injection valve as far as possible at the end of the injection period. It is also true that it is desirable to maintain pressure high on the discharge side of a pump to obtain a sharp and clean pumping action. If the pressure on the discharge side of the pump is allowed to drop to a low value at the end of each injection period this pressure must again be built up at the beginning of the succeeding stroke before it attains the necessary injection pressure and this drop and building up results in delays and irregularity in the pump action. With previous devices if the pressure is maintained in the atomizer or injector there is a tendency for dripping to occur at the atomizer and this produces unsatisfactory combustion conditions. It is one of the objects of the present invention to provide a device and a method whereby these two apparently conflicting requirements can be met, namely, that the pressure in the pipe between pump and atomizer is maintained at a high figure after the termination of each injection period, and that at the same time pressures within the atomizing valve are dropped sufficiently at or near the termination of the injection period to prevent ragged and dripping injection.

In the present solution of the problem the two requirements are separated and it is one of the objects of the invention to do this. This separation is accomplished in part by the use of a displacing device which may be located in the injection valve housing or in the pressure line.

Other objects will appear from time to time in the specification and claims.

The invention is illustrated more or less diagrammatically in the accompanying drawings, wherein:—

Figure 1 is a sectional view with parts in elevation showing one form of a device made according to the present invention and capable of carrying out the method of the invention;

Figure 2 is a longitudinal sectional detail taken on an enlarged scale showing the injector or atomizer valve and associated parts;

Figure 3 is a longitudinal section illustrating a control assembly made in a separate housing and attached to an atomizer or injector housing;

Figure 4 is a sectional view illustrating a further modification of the combination of the control unit, the pump and an atomizer or injector valve; and

Figure 5 is a further modification of the pressure-reversing valve.

Like parts are designated by like characters throughout the specification and drawings.

While the device is shown in Figures 1 and 2 as a complete single system comprising pump, atomizer valve and pressure-reversing valve, the invention might be made in separate parts and assembled as desired. Thus in Figure 3 the pressure-reversing valve is a separate unit and is merely attached to an atomizer or injection valve, while in Figure 4 the pump is separate from the valve and the pressure reversing valve in a self-contained housing is attached to a modified form of injection or atomizing valve.

As shown in Figures 1 and 2, 1 is a pump housing. 2 is a housing for the pump driving mechanism, 3 is a shaft for driving the pump, 4 is a pump barrel within which a piston 5 reciprocates. A cross head 6 may be used and a helical spring 7 within the cross head and about the pump barrel and piston may be used to return the piston to its original position when free to do so. The details of the pump construction and the pump drive need not be more fully shown since they form no essential part of the present invention, which may be associated with almost any style or arrangement of pump. A control valve 8, which communicates by a passage 9 with the pump chamber 10 may be used if desired and its control may be automatic or otherwise. 11 indicates a fluid intake passage controlled by a valve 12 and a spring 13. 14 is a fluid discharge passage having a discharge valve 15 and a spring 16 located within it. The passage 14 communicates by means of a conduit 17 with a member 18 having a passage 19 which is in communication with an injector or atomizer valve housing 20 having a bore 21. The housing 20 may be reduced and exteriorly threaded as at 22 to receive a valve liner 23 which is exteriorly threaded as at 24 to engage the interior threading of the member 22. The valve liner is generally closed as at 25 and may have one or more discharge openings 26. A filler piece 27 is positioned in the bore of the liner 23, is headed as at 28 and may have a cross cut 29 extending from side to side. Bearing upon the head 28 is a helical spring 30

which may be of any desired contour and shape but as shown is made of square wire in order to reduce the clearance space within the liner. This spring bears at its upper or inner end upon a flat valve member 31 which in turn bears upon a raised seat 32 formed on the member 33. A packing or other space-filling member 34 may be interposed between the inner end of the liner 23 and the outer face of the member 33. A similar packing 35 may be interposed between the inner face of the member 33 and the adjacent face of the housing 20.

A piston valve 36 provided with guiding lands 37 is situated in a bore formed in the member 33. A head 38 of the piston valve contacts the bore about its circumference and when the parts are in the position shown in Figure 2 prevents discharge from the bore 21 past the valve. It is only upon yielding of the spring 30, displacement of the flat valve 31 and passage of the head 38 beyond the outer end of the bore in the member 33 that fluid escapes into the cavity within the liner 23.

As shown in Figure 1 the injector valve is threaded into engagement with a cylinder wall 39 which may have a cooling jacket or chamber 40.

As shown in Figure 3, as above noted, the pressure reversing valve is positioned in a separate housing and is not formed within the general injector or atomizer housing as shown in Figure 2. Thus in Figure 3, 41 is a pressure reversing housing within which a bore 42 is formed. At its upstream end this housing is interiorly threaded as at 43 to receive a conduit 44 having a bore 45 through which fluid reaches the interior of the housing. A member 46 having a bore 47 is positioned within the housing 41 and may have packing 48 at its downstream end and packing 49 at its upstream end interposed between it and the inner end of the conduit member 44. Positioned within the bore 47 is a piston valve 50 having guiding lands 51, a head 52 and a reduced portion or annular groove 53 adjacent the head. The head 52 bears against a flat valve 54 positioned within an enlargement 55 of the bore 42. This flat valve at its lower or downstream side may have a depression or cup-like portion 56 within which the pointed end 57 of a stem 58 fits. A flange 59 extends laterally from the stem 58 and as shown is adjacent its upper end. A helical spring 60 is positioned about the stem, bears at one end against the flange 59 and at the other end against the upper surface of one or more adjustment members 61, the lower surface of which bears against a shoulder 62. The number and thickness of the adjustment members 61 is varied to give the desired compression upon the spring. The bore 42 may have one or more enlargements 63, 64 into which a portion of an injector or atomizer valve may extend. Adjacent its lower end the housing 41 is provided with an interiorly threaded cavity 65 within which the correspondingly threaded end 66 of an injector valve housing 67 may be removably positioned. Packing 68 may be interposed between the upper end of the threaded portion 66 and an inclined shoulder 69 of the housing.

In the form of the invention shown in Figure 4, 70 is a pump housing in the bore of which a piston or plunger 71 is mounted to reciprocate. 72 is an inlet conduit within the path of which an inlet valve 73 is positioned. 74 is an outlet or discharge conduit within which a discharge valve 75 is positioned. 76 is a valve housing within which a generally cylindrical piston valve 77 is positioned. This valve has a solid section 78 fluted as at 79 and provided with an annular groove or reduced portion 80. 81 are perforations running from the interior of the cylindrical portion and communicating with the clearance space 82. 83 is an enlarged head on the piston valve which when the parts are in the position shown in Figure 4 seats against the inclined seat 84 in the housing bore within the housing member 76. A spring 85 bears at one end against the enlarged head 83 and at its other bears against a pin or projection 86 formed in the housing member 76. 87 is an injector or atomizer valve housing having a bore 88 with an open end closed by a valve head 89 normally held seated by a stem 90 whose opposite end is threaded as at 91. Tension on the valve stem 90 may be adjusted by the nut 92. As shown the discharge end of the valve housing is exteriorly threaded as at 93 and is seated in a cylinder wall 94 which is provided with cooling means 95.

In the form of pressure reversing valve shown in Figure 5, the piston valve serves both as a piston valve and as a sealing valve. Thus there is a filler member 96 mounted within the housing 41. Upon its inner face is mounted a limiting or spacing member 97 which is perforated as at 98. 99 is a packing. 100 is a piston valve having guiding vanes 101, an annular groove 102 and a head 103. The head is provided with a depression 104 into which a projection or point 105 of a stem 106 penetrates. This projection 105 is approximately the same as the point 57 of Figure 3 except that it is reduced in size. The stem 106 corresponds generally to the stem 58 of Figure 3. A spring 107 is positioned within the housing cavity 55, surrounds the stem 106 and serves to hold it in the upper position in the same manner as does the spring 60 in the form illustrated in Figure 3.

The use and operation of my invention are as follows:

While the various forms of the device differ from each other in detail of construction and of assembly, in general they have close similarity in operation. Consequently the operation of the several forms may be considered as being substantially uniform.

The so-called pressure reversing valve in the forms shown in Figures 1, 2 and 3 is a two-part valve including the relatively flat valve and the piston valve. Thus in Figure 2 there is a flat valve 31 and the piston valve 36. In Figure 3 there is the relatively flat valve 54 and the piston valve 50, while in Figure 4 the cylindrical portion of the piston valve 77 is integral with the head portion 79, 83. Thus with the exception of the form shown in Figure 4, the pressure reversing valve comprises in reality two separate valves each performing a different function.

Considering the operation of the form of Figure 3, the direction of flow is that of the dart. At the beginning of injection the pressure in the fluid line forces the piston valve 50 downwardly. This in turn forces back the flat valve 54, unseating it and compressing the spring 60. Little or no flow will take place at first past the flat valve until the head of the piston valve passes the lip of the seat so that the annular groove or cut-away portion of the piston valve clears the seat formed at the outer end of the member 46. Then flow takes place into the atomizer. Pressure is built up and the atomizer itself discharges. During injection the valve system, including the piston

valve and the flat valve, is held a considerable distance off its seat, this distance being determined by the length of the piston portion of the piston valve. In one form the spring rate is exceedingly high, with the result that the pressure in the system rises as the valve opens and it may in some installations take in the neighborhood of 50% more pressure to hold the valve open than that required to initiate opening. The result of this effect is that when pressure is dropped, for example, upon the opening of a control valve in the pump or for any other reason, the spring accelerates the relatively heavy valve parts very rapidly, stores energy in them and drives the piston valve back violently.

After the piston valve has been driven back to the point where the lip of the portion 52 passes the seat it causes a negative displacement in the atomizer cavity. This cavity is of relatively small volume and this negative displacement forcing a quantity of fluid back into the pressure line, tends to keep the pressure up in the line, which is desirable from the standpoint of pump and operating efficiency. At the same time a drop in pressure within the atomizer housing proper is accomplished and this is desirable to stop dripping at the atomizer valve and to cause sharp and clean termination of atomization. Thus in the operation of this device, upon the termination of injection, pressure within the fluid line to the injector valve is kept up and simultaneously pressure within the injection valve housing is decidedly reduced. Therefore the device shown accomplishes the important purpose of a sharp pressure diminution in the injector or atomizer valve to prevent unsatisfactory atomization and at the same time largely maintains pressure within the fluid line up to the point of the injector valve and increases the efficiency of the total operation since upon the succeeding injection operation it is necessary to build up pressure within the fluid line from the pump to the atomizer valve by a much less degree than would be necessary if pressure throughout the entire line had been reduced as would be necessary in other constructions.

The method of operation of the device shown in Figures 1 and 2 is generally the same as that above described for the form of Figure 3 except that the pressure reversing valve assembly, instead of being in a separate housing is mounted in the same housing with the injection valve. That is to say, the piston valve and the flat valve are in the same housing with the injection valve. The fluid under pressure enters from the pump through the conduit provided for it and passes into the interior of the housing. The pressure forces the piston valve and the flat valve down. When the flat valve has been sufficiently displaced from its seat to permit the lip of the piston valve to pass beyond the edge of the seat so that the annular groove in the piston valve clears the seat, fluid under pressure then enters the lower portion of the valve housing cavity or bore within which the filler piece and the spring are positioned. Each of the last two pieces is made relatively large to reduce the clearance within this portion of the valve housing. The operation of the valve assembly is otherwise substantially the same as that described above.

In the form of the device shown in Figure 4, as above noted, the piston valve carries a head which to some degree serves the same purpose as that served by the flat valves of Figures 2 and 3. Pressure fluid enters the housing which encloses the piston valve. When sufficient movement of the piston valve has occurred, fluid under pressure moves past it into the space which houses the spring and thence into the bore of the atomizer or injection housing. Sufficient pressure within this housing is effective upon the atomizer valve head and slightly elongates or stretches the stem, causing unseating of the head and atomization or other discharge of fuel from the valve. Upon the diminution of pressure in the pump or conduit, due for example to the action of a relief valve, the piston valve is snapped back by the spring and pressure is suddenly relieved within the atomizer housing, causing smooth and sharp termination of atomization and the piston acts also to increase pressure within the fuel line and thus to prevent the extreme pressure reduction in the line which, as above pointed out, is undesirable and which it is one of the objects of the present invention to prevent.

I claim:

1. The method of atomizing liquid in a system which includes a pump and an atomizer having a valve and a discharge opening and a connecting passage, which method includes the following steps: subjecting liquid to pressure within the pump, moving it under pressure along the connecting passage, causing it to discharge from the atomizer, stopping the flow of liquid from the pump to the atomizer, greatly reducing pressure in the atomizer while tending to maintain pressure in the connecting passage.

2. The method of atomizing liquid in a system which includes a pump and an atomizer having a valve and a discharge opening and a connecting passage, which method includes the following steps: subjecting liquid to pressure within the pump, moving a quantity of liquid under pressure along the connecting passage, moving it into the atomizer, causing it to discharge from the atomizer, stopping the flow of liquid from the pump to the atomizer, tending to compress the liquid in the connecting passage.

3. The method of atomizing liquid in a system which includes a pump and an atomizer having a valve and a discharge opening and a connecting passage, which method includes the following steps: subjecting liquid to pressure within the pump, moving a quantity of liquid under pressure along the connecting passage, moving it into the atomizer, causing it to discharge from the atomizer, stopping the flow of liquid from the pump to the atomizer, tending to increase the pressure of the liquid in the connecting passage.

4. The method of atomizing liquid in a system which includes a pump and an atomizer having a valve and a discharge opening and a connecting passage, which method includes the following steps: subjecting liquid to pressure within the pump, moving a quantity of liquid under pressure along the connecting passage, moving it into the atomizer, causing it to discharge from the atomizer, stopping the flow of liquid from the pump to the atomizer, displacing a small portion of liquid away from the normal discharge opening of the atomizer and tending to compress the liquid in the connecting passage.

5. The method of atomizing liquid in a system which includes a pump and an atomizer having a valve and a discharge opening and a connecting passage, which method includes the following steps: subjecting liquid to pressure within the pump, moving a quantity of liquid under pressure along the connecting passage, moving it into the

atomizer, causing it to discharge from the atomizer, stopping the flow of liquid from the pump to the atomizer, displacing a small portion of liquid away from the normal discharge opening of the atomizer and tending to increase the pressure of the liquid in the connecting passage.

6. In combination with a fuel atomizer for internal combustion engines, an atomizer housing, an atomizer discharge orifice, means for conveying fuel under pressure to said housing and orifice, said means including a liquid supply passage and means in combination with said atomizer effective upon fuel in said supply passage and fuel in said atomizer to withdraw fuel from said atomizing orifice and tending to compress fuel within said supply passage.

7. In combination with a fuel atomizer for internal combustion engines, an atomizer housing, an atomizer discharge orifice, means for conveying fuel under pressure to said housing and orifice, said means including a liquid supply passage and means in combination with said atomizer effective upon fuel in said supply passage and fuel in said atomizer to withdraw fuel from said atomizing orifice and tending to compress fuel within said supply passage, said last mentioned means comprising a member movably mounted in the supply passage adjacent the atomizer and performing the following cycle of operations: first, closing the fuel passage, second, moving toward the atomizing orifice under the influence of pressure within the supply passage and opening the passage to the atomizing orifice, third, moving away from the atomizing orifice upon diminution of pressure within the supply passage, withdrawing fuel from the atomizing orifice, closing the supply passage and tending to compress fuel therewithin.

8. In combination with a fuel atomizer for internal combustion engines, an atomizer housing, an atomizer discharge orifice, means for conveying fuel under pressure to said housing and orifice, said means including a liquid supply passage and means in combination with said atomizer effective upon fuel in said supply passage and fuel in said atomizer to withdraw fuel from said atomizing orifice and tending to compress fuel within said supply passage, said last mentioned means comprising a pressure reversing valve positioned in the liquid supply passage.

9. In combination with a fuel atomizer for internal combustion engines, an atomizer housing, an atomizer discharge orifice, means for conveying fuel under pressure to said housing and orifice, said means including a liquid supply passage and means in combination with said atomizer effective upon fuel in said supply passage and fuel in said atomizer to withdraw fuel from said atomizing orifice and tending to compress fuel within said supply passage, said last mentioned means comprising a pressure reversing valve positioned in the liquid supply passage, and a sealing valve.

10. In combination with a fuel atomizer for internal combustion engines, an atomizer housing, an atomizer discharge orifice, means for conveying fuel under pressure to said housing and orifice, said means including a liquid supply passage and means in combination with said atomizer effective upon fuel in said supply passage and fuel in said atomizer to withdraw fuel from said atomizing orifice and tending to compress fuel within said supply passage, said last mentioned means comprising a piston valve positioned in the liquid supply passage.

11. In combination with a fuel atomizer for internal combustion engines, an atomizer housing, an atomizer discharge orifice, means for conveying fuel under pressure to said housing and orifice, said means including a liquid supply passage and means in combination with said atomizer effective upon fuel in said supply passage and fuel in said atomizer to withdraw fuel from said atomizing orifice and tending to compress fuel within said supply passage, said last mentioned means comprising a piston valve and a flat sealing valve positioned in the liquid supply passage.

12. In combination with a fuel atomizer for internal combustion engines, an atomizer housing, an atomizer discharge orifice, means for conveying fuel under pressure to said housing and orifice, said means including a liquid supply passage and means in combination with said atomizer effective upon fuel in said supply passage and fuel in said atomizer to withdraw fuel from said atomizing orifice and tending to compress fuel within said supply passage, said last mentioned means comprising a spring loaded pressure-reversing valve.

13. In combination with a fuel atomizer for internal combustion engines, an atomizer housing, an atomizer discharge orifice, means for conveying fuel under pressure to said housing and orifice, said means including a liquid supply passage and means in combination with said atomizer effective upon fuel in said supply passage and fuel in said atomizer to withdraw fuel from said atomizing orifice and tending to compress fuel within said supply passage, said last mentioned means comprising a pressure-reversing valve and a spring loaded sealing valve positioned to co-operate with said pressure-reversing valve.

14. In combination with a fuel atomizer for internal combustion engines, a hollow housing, a fuel passage therein, a discharge orifice therefrom, a valve movably positioned in the fuel passage, a sealing valve mounted to co-operate with said first mentioned valve, a spring positioned within said housing, tending to seat said sealing valve, the spring adapted to yield under the influence of pressure within the fuel passage to cause unseating of the sealing valve and opening movement of the first mentioned valve, the spring being effective upon diminution of pressure within the fuel passage to return the first mentioned valve and to seat the sealing valve.

15. In combination with a fuel atomizer for internal combustion engines, a hollow housing, a fuel passage therein, a discharge orifice therefrom a piston valve movably positioned in the fuel passage, a sealing valve mounted to co-operate with said piston valve, a spring positioned within said housing, tending to seat said sealing valve, the spring adapted to yield under the influence of pressure within the fuel passage to cause unseating of the sealing valve and opening movement of the piston valve, the spring being effective upon diminution of pressure within the fuel passage to return the piston valve and to seat the sealing valve.

16. In combination with a fuel atomizer for internal combustion engines, a hollow housing, a fuel passage therein, a discharge orifice therefrom, a valve movably positioned in the fuel passage, a sealing valve mounted to co-operate with said first mentioned valve, a spring positioned within said housing, tending to seat said sealing valve, the spring adapted to yield under the influence of pressure within the fuel passage to cause unseating of the sealing valve and opening movement of the first mentioned valve, the spring

being effective upon diminution of pressure within the fuel passage to return the first mentioned valve and to seat the sealing valve, and causing withdrawal of fuel from the atomizing orifice.

17. In combination with a fuel atomizer for internal combustion engines, a hollow housing, a fuel passage therein, a discharge orifice therefrom, a valve movably positioned in the fuel passage, a sealing valve mounted to co-operate with said first mentioned valve, a spring positioned within said housing, tending to seat said sealing valve, the spring adapted to yield under the influence of pressure within the fuel passage to cause unseating of the sealing valve and opening movement of the first mentioned valve, the spring being effective upon diminution of pressure within the fuel passage to return the first mentioned valve and to seat the sealing valve, and causing partial recompression of fuel within the fuel passage.

18. In combination with a fuel atomizer for internal combustion engines, a hollow housing, a fuel passage therein, a discharge orifice therefrom, a valve movably positioned in the fuel passage, a sealing valve mounted to co-operate with said first mentioned valve, a spring positioned within said housing, tending to seat said sealing valve, the spring adapted to yield under the influence of pressure within the fuel passage to cause unseating of the sealing valve and opening movement of the first mentioned valve, the spring being effective upon diminution of pressure within the fuel passage to return the first mentioned valve and to seat the sealing valve, and causing withdrawal of fuel from the atomizing orifice and partial recompression of fuel within the fuel passage.

19. In combination with a fuel atomizer for internal combustion engines, a hollow housing, a fuel passage therein, a discharge orifice therefrom, a valve movably positioned in the fuel passage, a sealing valve mounted to co-operate with said first mentioned valve, a spring positioned within said housing tending to seat said sealing valve, a filler member positioned within said housing, the spring adapted to yield under the influence of pressure within the fuel passage to cause unseating of the sealing valve and opening movement of the first mentioned valve, the spring being effective upon diminution of pressure within the fuel passage to return the first mentioned valve and to seat the sealing valve.

20. In combination with a fuel atomizer for internal combustion engines, a hollow housing, a fuel passage therein, a discharge orifice therefrom, a piston valve movably positioned in the fuel passage, a sealing valve mounted to co-operate with said piston valve, a spring positioned within said housing, tending to seat said sealing valve, a filler member positioned within said housing, the spring adapted to yield under the influence of pressure within the fuel passage to cause unseating of the sealing valve and opening movement of the piston valve, the spring being effective upon diminution of pressure within the fuel passage to return the piston valve and to seat the sealing valve, and causing withdrawal of fuel from the atomizing orifice and partial recompression of fuel within the fuel passage.

PHILIP LANE SCOTT.