

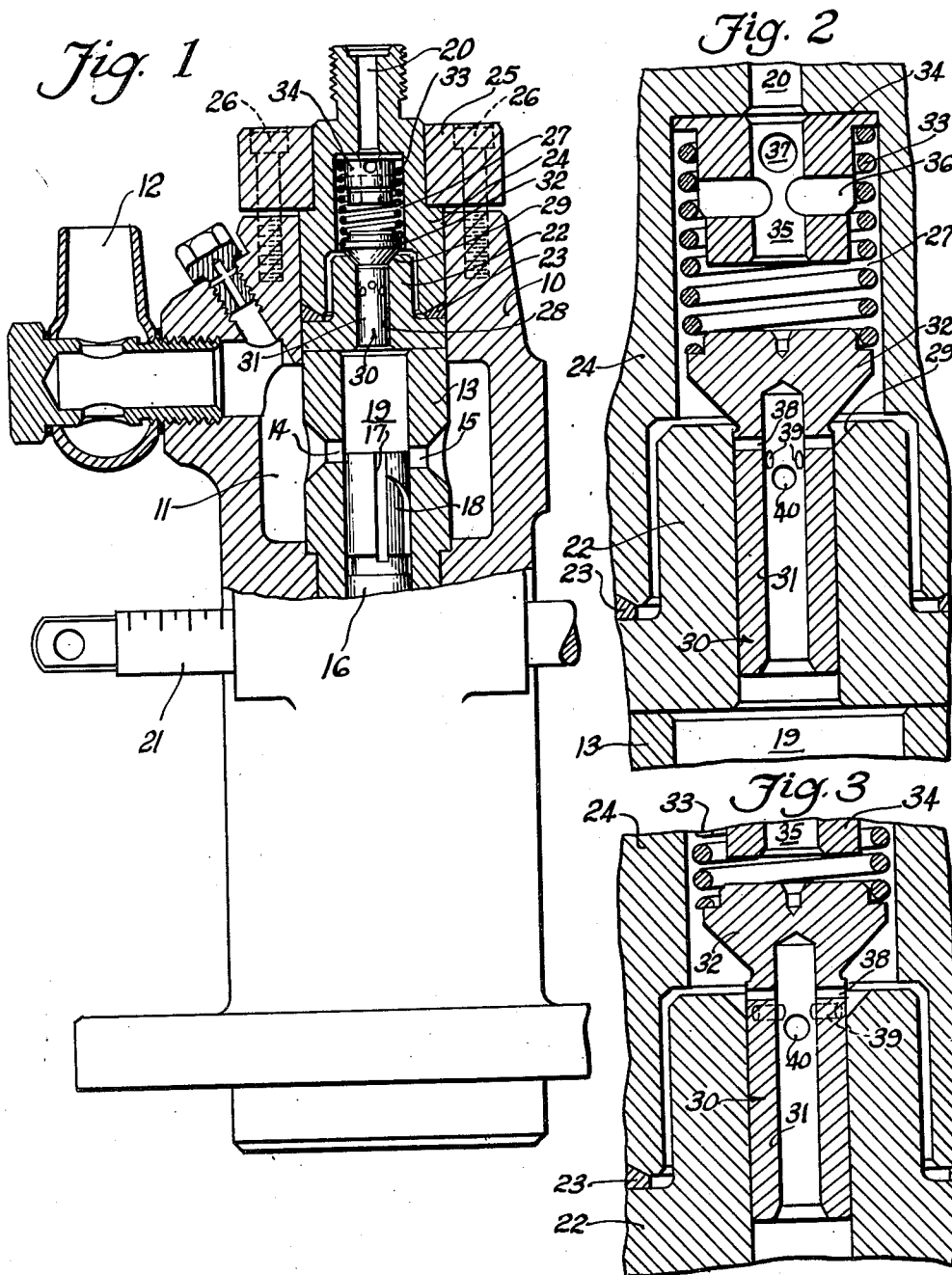
Oct. 7, 1952

R. A. LASLEY
VARIABLE RETRACTION DISCHARGE VALVE
FOR FUEL INJECTION PUMPS

2,612,841

Filed Sept. 29, 1948

2 SHEETS—SHEET 1



INVENTOR.
Robert A. Lasley
BY
Mason, Kolehmainen, Rathburn & Wyss
Att'ys

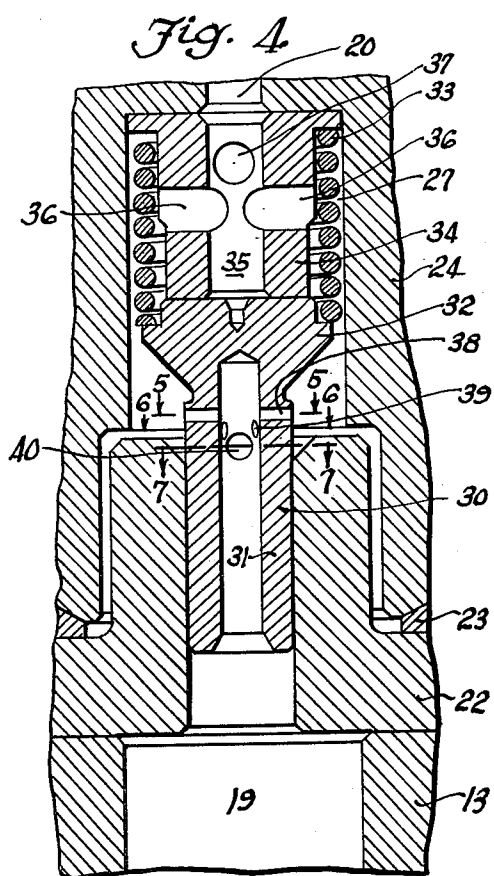
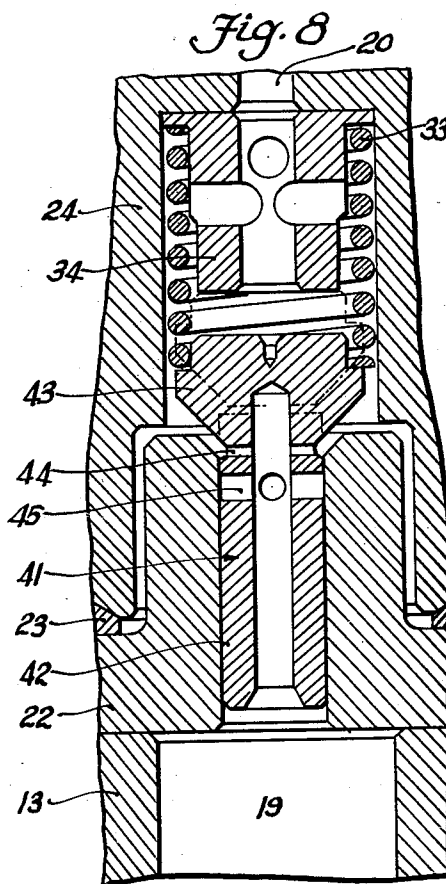
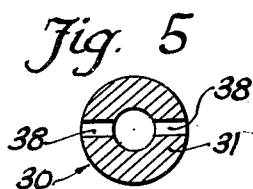
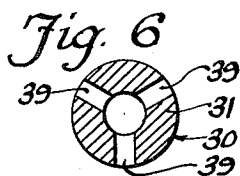
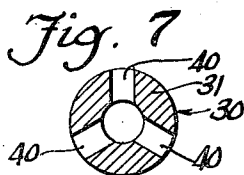
Oct. 7, 1952

R. A. LASLEY
VARIABLE RETRACTION DISCHARGE VALVE
FOR FUEL INJECTION PUMPS

2,612,841

Filed Sept. 29, 1948

2 SHEETS—SHEET 2



INVENTOR.
Robert A. Lasley
BY
Mason, Kolehmainen, Rothburn & Niss
Attys

UNITED STATES PATENT OFFICE

2,612,841

VARIABLE RETRACTION DISCHARGE VALVE
FOR FUEL INJECTION PUMPSRobert A. Lasley, Chicago, Ill., assignor, by mesne
assignments, to Louis G. Simmons, Chicago, Ill.

Application September 29, 1948, Serial No. 51,816

5 Claims. (Cl. 103-41)

1

This invention relates to variable retraction discharge valves for fuel injection pumps, more particularly to discharge valves of the type employed in fuel injection systems wherein a pressure operated injector or nozzle is connected through a closed fuel line to the high pressure outlet of a pump which is adjustably operable to supply metered amounts of fuel under high pressure at each stroke of the pump and to relieve the high pressure abruptly upon delivery of the metered amount of fuel, and the invention has for an object the provision of improved discharge valve means which automatically vary in accordance with the amount of fuel delivered by the pump at each stroke, the amount of fuel retracted or withdrawn from the fuel line upon closure of the discharge valve.

As set forth in a prior application, Serial No. 26,850, filed May 13, 1948, in the name of the present inventor, for Fuel Injection Systems of which this application is a continuation in part, fuel injection systems of the above character ordinarily include a fuel pump having a spring load discharge valve adapted to close quickly upon release of the pump pressure so as to prevent return of fuel from the fuel line to the pump between injections, and difficulties have been encountered with secondary injection caused by the pressure wave that is set up in the sealed fuel line upon closure of the injector nozzle. Prior to the invention disclosed in the aforesaid application, it was proposed to minimize or eliminate such secondary injection or dribble at the fuel injector nozzle by designing the discharge valves of the pumps to provide a predetermined amount of retraction upon closure, that is, withdrawal of fuel from the fuel line during closure of the discharge valve.

The amount of fuel to be withdrawn from the fuel line to prevent secondary injection without interfering with the accuracy of subsequent primary injections depends on numerous factors including primarily the amount of fuel injected, which is a function of the load and speed of the engine. If too much retraction is provided the fuel line may be partially emptied and consequently insufficient fuel may be supplied to the injector for the next injection, particularly at light loads, while if too little retraction is provided secondary injection may not be prevented. Consequently, it was the practice prior to the invention of the aforesaid application to design the discharge valves so as to provide the minimum amount of re-

2

traction necessary for satisfactory injection at normal loads and speeds with the result that the range of loads and speeds that the engine could deliver without encountering objectionable injection characteristics was severely limited.

The said prior application discloses and broadly claims improved fuel injection systems wherein the above indicated problem is overcome by incorporating in the system means for automatically varying in accordance with the amount of fuel delivered by the pump under various load-speed conditions, the amount of retraction, i. e., the amount of fuel withdrawn from the fuel line between injections. Although the specific constructions disclosed in the said prior application operate satisfactorily to accomplish the intended purposes the incorporation in such systems of a plurality of discharge valves involves additional expense and the particular single valve embodiment disclosed in the said application involves manufacturing difficulties due to certain critical design factors. Accordingly it is a further object of this invention to provide improved variable retraction discharge valves, for use in such systems, which may be manufactured at low cost and which operate with reliability and accuracy.

In carrying out the invention in one form a variable retraction discharge valve is provided comprising a valve member having a hollow stem portion closed at one end and an annular head portion surrounding the stem adjacent the closed end, and the stem portion is provided with a plurality of apertures extending through the wall thereof beneath the annular head, the apertures being spaced axially of the stem portion and graduated in size so as automatically to vary in accordance with the amount of fuel delivered by the pump the extent of the opening movement imparted to the valve member and the amount of retraction effected during closing movement of the valve member.

For a more complete understanding of the invention, reference should now be had to the drawings in which:

Fig. 1 is an elevational view partly in section of a fuel pump provided with discharge valve means embodying the present invention;

Fig. 2 is a fragmentary sectional view on a larger scale showing the valve means of Fig. 1 in an operated position corresponding to light loads;

Fig. 3 is a fragmentary view similar to Fig.

3

2 but showing the valve in an operated position corresponding to intermediate loads;

Fig. 4 is a fragmentary view similar to Figs. 2 and 3 showing the valve in an operated position corresponding to maximum load;

Figs. 5, 6 and 7 are detail sectional views taken respectively along the lines 5—5, 6—6 and 7—7 of Fig. 4; and

Fig. 8 is a fragmentary sectional view similar to Fig. 2 showing a further embodiment of the invention.

Referring now to the drawings the invention is shown as embodied in a fuel pump of a type well known in the art comprising a longitudinally bored pump body 10 formed to provide a primary fuel chamber 11 to which fuel is supplied through a suitable inlet fitting 12. Disposed within the pump body 10 is a cylinder barrel 13 having an inlet port 14 and a spill port 15 communicating with the fuel chamber 11. The cylinder barrel 13 as shown contains a reciprocable piston 16 which is provided adjacent its upper end with a longitudinally extending slot 17 which communicates with an inclined or helically disposed slot 18 adapted to cooperate with the spill port 15 in a manner well understood in the art and which will be briefly described hereinafter.

As will be understood by those skilled in the art, the pump is of the constant stroke type and the piston 16 is rotatably adjustable in the cylinder barrel 13 to vary the amount of high pressure fuel delivered at each stroke of the pump. When the piston is in its lowermost position the pressure chamber 19 within the cylinder barrel and above the piston will be filled with fuel by suction through the inlet port 14 and the spill port 15. As the piston begins its upward travel the fuel in the chamber 19 will be placed under pressure and as soon as the upper edge of the piston moves beyond the inlet port 14, high pressure will be developed so as to force fuel through the discharge valve, as hereinafter described, and through the high pressure outlet passage 20 of the pump to the fuel line and the injector nozzle (not shown). As soon as the piston reaches a position in which the helical groove 18 communicates with the spill port 15, the pressure chamber 19 above the piston will be immediately relieved and consequently the amount of fuel discharged from the pump on each stroke may be adjusted by rotating the piston 16 so as to vary the point in its stroke at which communication of the inclined groove 18 with the spill port 15 will be established.

Various mechanisms well known to the art may be employed for effecting rotation of the piston 16 to adjust the capacity of the pump and it is not believed necessary to illustrate or describe such mechanism further than to point out that a slidable rack 21 is connected to the adjusting mechanism so as to effect rotation of the piston 16, the rack 21 preferably being provided with suitable calibrations, as shown, to indicate the adjustment of the piston in the cylinder barrel. Fuel pumps of the type shown and thus far described are well known in the art and constitute no part of the present invention.

Mounted directly above the cylinder barrel 13 in the bore of the pump body 10 is a suitable valve guide 22 adapted to be engaged and held in position by a compressible sealing ring 23 which is in turn engaged by a retainer member 24 mounted within the bore of the pump body

4

and held in place by a cap member 25 secured to the pump body by suitable cap screws 25.

As shown the retainer member 24 is shaped to provide in conjunction with the valve guide 22 a valve chamber 27 which communicates directly with the high pressure pump outlet 20, the valve guide 22 being bored to provide an opening 28 which communicates with the pressure chamber 19 of the pump, the upper surface of the valve guide 22 being formed to provide an annular valve seat 29. Disposed within the opening 28 in the valve guide 22 is a valve member 30 which includes a hollow stem portion 31 which is closed at its upper end, as shown best in Fig. 2 and is provided with an enlarged valve head 32 adapted to engage the valve seat 29. Disposed within the valve chamber 27 is a valve spring 33 the lower end of which engages a suitable shoulder on the valve head 32 and the upper end of which engages a suitable flange on a stop member 34 which is disposed within the valve chamber 27 and provided with suitable apertures 35, 36 and 37 communicating the valve chamber 27 with the pressure outlet 20.

The valve spring 33 functions to maintain the valve member 30 in the closed position shown in Fig. 1 with the head 32 engaging the valve seat 29 during low pressure portions of the pump cycle and it will be apparent to those skilled in the art that when pressure is developed in the pump chamber 19, the valve 30 will be lifted by the pressure so as to move inwardly of the valve chamber 27 against the force of the spring 33 thereby lifting the valve head 32 out of engagement with the valve seat 29.

In accordance with the present invention the hollow valve stem 31 is provided immediately below the valve head 32 with a plurality of sets of apertures 38, 39, and 40. As shown best in Figs. 5, 6 and 7, the set of apertures 38 includes a pair of oppositely disposed apertures of relatively small cross-section, the set of apertures 39 includes three apertures which are symmetrically disposed and of somewhat larger cross-section, and the set of apertures 40 includes three apertures similarly spaced but of still larger cross-section. In accordance with the present invention the axial spacing and the relative cross-sections of the three sets of apertures are so correlated that the amount of lift imparted to the valve member 30 and consequently the amount of retraction effected by the valve member during closing movement thereof, is a function of the amount of fuel delivered by the pump during each stroke.

In Fig. 2 the valve member 30 is shown in the position to which it will be moved under light load conditions and it will be observed that only the apertures 38 have moved to a position beyond the valve seat 29 so as to establish communication between the pressure chamber 19 and the valve chamber 27. The amount of communication provided by the apertures 38 being sufficient to accommodate the amount of oil supplied under pressure by the pump under these load conditions, no further lifting movement of the valve member 30 takes place and consequently only a small amount of retraction occurs upon closure of the valve after the pressure in the pump chamber 19 is released.

In Fig. 3 the valve member 30 is shown in a position corresponding to intermediate load conditions and it will be observed that in this position both the apertures 38 and the apertures 39 have been uncovered. Accordingly, the valve

lift being greater under these load conditions, a greater amount of retraction is obtained. In Fig. 4 the valve member 30 is shown in its maximum lift position corresponding to maximum load conditions, the head 32 being engaged by the stop member 34 and all of the apertures 38, 39 and 40 being uncovered to permit the flow of oil from the pressure chamber 19 to the valve chamber 27. It will be understood, of course, that in addition to the three positions shown in Figs. 2, 3 and 4 the valve member 30 may occupy an unlimited number of intermediate positions in which some or all of the apertures 38, 39 and 40 are wholly or partially uncovered, the positions to which the valve moves being determined by the amount of fuel delivered by the pump on its pressure stroke. Thus the lift of the valve and the amount of retraction provided varies automatically in accordance with the operating condition of the pump and the fuel injection system, whereby secondary injection effects are avoided over a wide range of load-speed conditions.

In the embodiment of the invention shown in Fig. 8 similar reference numerals have been applied to similar parts, the only difference being that in this embodiment of the invention a valve member 41 is provided having a hollow stem portion 42 which is provided immediately below the head member 43 with two sets of axially spaced apertures 44 and 45 which are graduated in size to provide for automatic variation of the valve lift and retraction in the manner heretofore described in connection with the embodiment of Figs. 1 to 7. The provision of the three sets of graduated apertures in the first described embodiment provides a somewhat finer regulation of the retraction although satisfactory operation may be obtained with the embodiment of the invention disclosed in Fig. 8.

While a particular embodiment of the invention has been shown, it will be understood, of course, that the invention is not to be limited thereto, since many modifications may be made, and it is contemplated, therefore, by the appended claims, to cover any such modifications as fall within the true spirit and scope of the invention.

What is desired to be secured by Letters Patent of the United States is:

1. Variable retraction discharge valve means for a fuel injection system including a variable delivery pump for supplying metered amounts of fuel to a fuel line, said discharge valve means comprising a valve chamber in open communication with said fuel line and having a valve opening communicating with said pump and forming a valve seat, a hollow valve member slidably disposed in and substantially closing said opening and having a closed end extending into said chamber, a valve head on said valve member for engaging said valve seat, said valve member having radial apertures extending through the wall thereof below said valve head for communicating said pump with said valve chamber when said valve member moves inwardly of said chamber in response to the pressure developed by said pump, and spring means for moving said valve member outwardly to engage said valve head with said valve seat and to retract fuel from said fuel line upon release of said pump pressure, said apertures being spaced axially of said valve member so as to open in sequence and automatically vary in accordance with the amount of fuel delivered by said pump the extent of inward movement of said valve member and the amount of

retraction effected during outward movement thereof.

2. Variable retraction discharge valve means for a fuel injection system including a variable delivery pump for supplying metered amounts of fuel to a fuel line, said discharge valve means comprising a valve chamber in open communication with said fuel line and having a valve opening communicating with said pump and forming a valve seat, a hollow valve member slidably disposed in and substantially closing said opening and having a closed end extending into said chamber, a valve head on said valve member for engaging said valve seat, said valve member having radial apertures extending through the wall thereof below said valve head for communicating said pump with said valve chamber when said valve member moves inwardly of said chamber in response to the pressure developed by said pump, spring means for moving said valve member outwardly to engage said valve head with said valve seat and to retract fuel from said fuel line upon release of said pump pressure, said apertures being arranged in axially spaced sets graduated in size so as automatically to vary in accordance with the amount of fuel delivered by said pump the extent of inward movement of said valve member and the amount of retraction effected during said outward movement thereof.

3. Variable retraction discharge valve means for a fuel injection system including a variable delivery pump for supplying metered amounts of fuel to a fuel line, said discharge valve means comprising a valve chamber in open communication with said fuel line and having a valve opening communicating with said pump and forming a valve seat, a hollow member slidably disposed in and substantially closing said opening and having a closed end extending into said chamber, a valve head on said valve member for engaging said valve seat, said valve member having apertures in the wall thereof below said valve head for communicating said pump with said valve chamber when said valve member moves inwardly of said chamber in response to the pressure developed by said pump, spring means for moving said valve member outwardly to engage said valve head with said valve seat and to retract fuel from said fuel line upon release of said pump pressure, said apertures being arranged in axially spaced sets and with the area of each set increasing as the spacing from said valve head increases so as to automatically vary in accordance with the amount of fuel delivered by said pump the extent of inward movement of said valve member and the amount of retraction effected thereby during outward movement thereof.

4. Variable retraction discharge valve means for a fuel injection system including a variable delivery pump for supplying metered amounts of fuel to a fuel line, said discharge valve means comprising a valve chamber in open communication with said fuel line and having a valve opening communicating with said pump and forming a valve seat, a hollow valve member slidably disposed in and substantially closing said opening and having a closed end extending into said chamber, a valve head on said valve member for engaging said valve seat, said valve member having apertures in the wall thereof below said valve head for communicating said pump with said valve chamber when said valve member moves inwardly of said chamber in response to the pressure developed by said pump, spring means for moving said valve member outwardly to engage

7

said valve head with said valve seat and to retract fuel from said fuel line upon release of said pump pressure, said apertures being spaced axially of said valve member so as automatically to vary in accordance with the amount of fuel delivered by said pump the extent of inward movement of said valve member and the amount of retraction effected during outward movement thereof, and stop means in said chamber for limiting to a predetermined maximum the inward movement of said valve member.

5. Variable retraction discharge valve means for a fuel injection system including a variable delivery pump for supplying metered amounts of fuel to a fuel line, said discharge valve means comprising a valve chamber in open communication with said fuel line and having a valve opening communicating with said pump and forming a valve seat, a hollow valve member slidably disposed in and substantially closing said opening and having a closed end extending into said chamber, a valve head on said valve member for engaging said valve seat, said valve member having apertures in the wall thereof below said valve head for communicating said pump with said valve chamber when said valve member moves inwardly of said chamber in response to the pressure developed by said pump, spring means for moving said valve member outwardly to engage said valve head with said valve seat and to retract fuel from said fuel line upon release of said pump

8

pressure, said apertures being spaced axially of said valve member so as automatically to vary in accordance with the amount of fuel delivered by said pump the extent of inward movement of said valve member and the amount of retraction effected during outward movement thereof, and stop means in said chamber engageable by said valve member to prevent further inward movement thereof after the set of apertures most remote from said valve head communicates with said chamber.

ROBERT A. LASLEY.

REFERENCES CITED

- 15 The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
20 977,723	Field	Dec. 6, 1910
1,919,856	McGeorge	July 25, 1933
1,954,662	Bond	Apr. 10, 1934
2,126,985	Buckwalter	Aug. 16, 1938
2,178,902	Clausen	Nov. 7, 1939
25 2,211,252	Bremser	Aug. 13, 1940
2,234,936	Streby	Mar. 11, 1941
2,382,000	Bremser	Aug. 14, 1945

FOREIGN PATENTS

Number	Country	Date
30 481,807	Great Britain	1938