

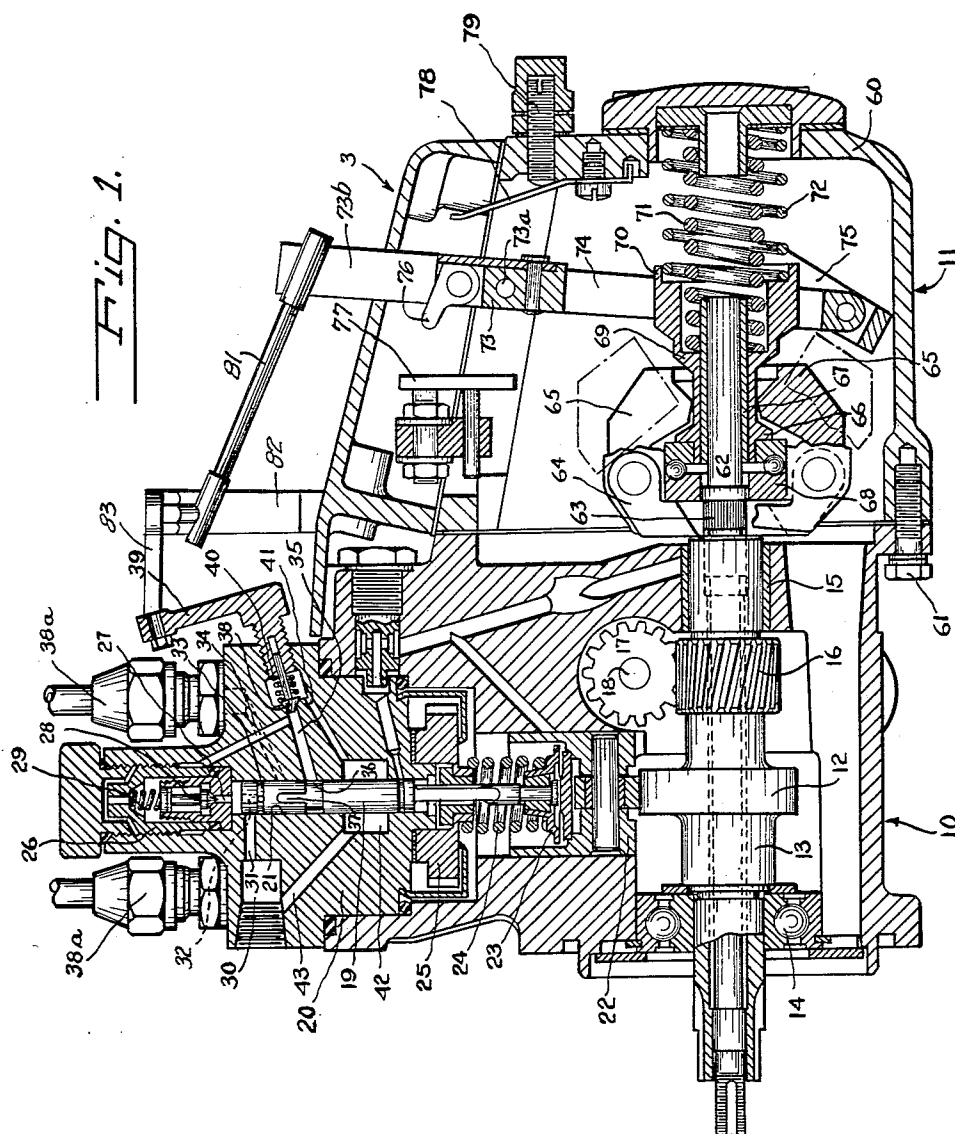
June 4, 1957

P. G. BURMAN
FUEL INJECTION PUMP

2,794,397

Filed April 19, 1952

3 Sheets-Sheet 1



INVENTOR.
PAUL G. BURMAN

BY

Raymond A. Paquin

ATTORNEY.

June 4, 1957

P. G. BURMAN
FUEL INJECTION PUMP

2,794,397

Filed April 19, 1952

3 Sheets-Sheet 2

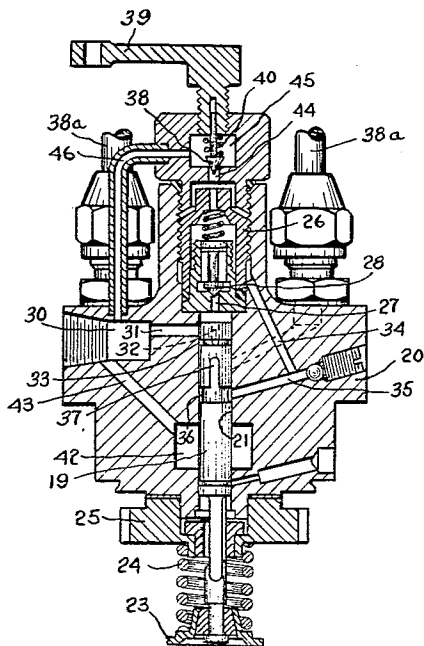


Fig. 2

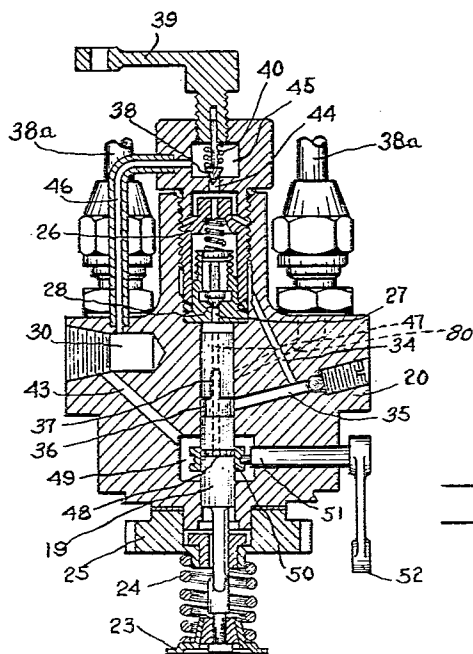


Fig. 3

INVENTOR.
PAUL G. BURMAN
BY *Raymond A. Ragun*
ATTORNEY.

June 4, 1957

P. G. BURMAN
FUEL INJECTION PUMP

2,794,397

Filed April 19, 1952

3 Sheets-Sheet 3

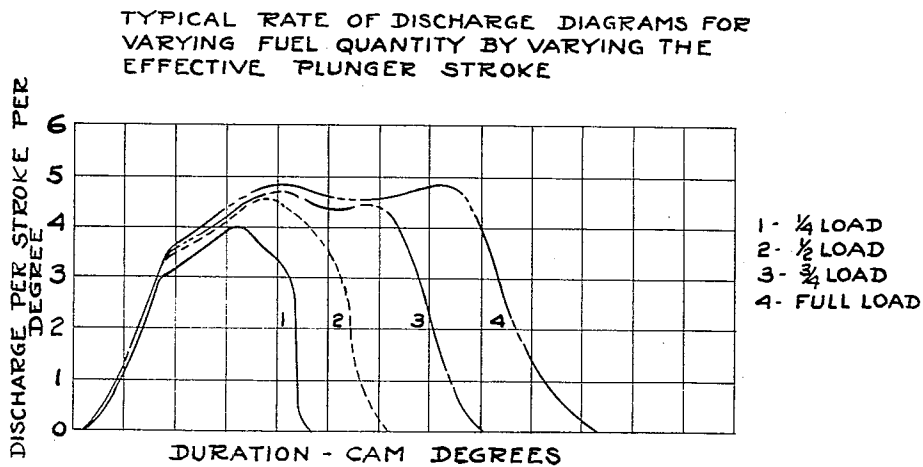
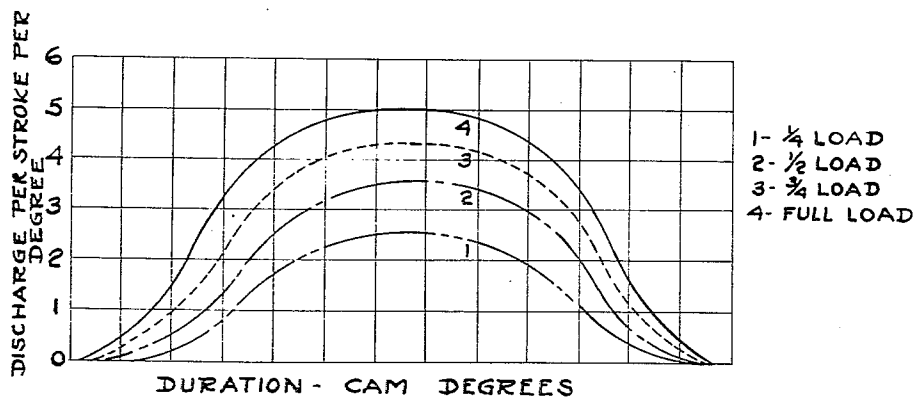


Fig. 4.



TYPICAL RATE OF DISCHARGE
FOR VARYING FUEL QUANTITY BY
VARYING THE AMOUNT OF FUEL
SPILLED THRUOUT THE CONSTANT
EFFECTIVE PLUNGER STROKE

Fig. 5.

INVENTOR.
PAUL G. BURMAN

BY

Raymond A. Laguerre

ATTORNEY.

1

2,794,397

FUEL INJECTION PUMP

Paul G. Burman, Longmeadow, Mass., assignor to American Bosch Arma Corporation, a corporation of New York

Application April 19, 1952, Serial No. 283,197

2 Claims. (Cl. 103—2)

This invention relates to fuel injection apparatus and has particular reference to a new and improved fuel injection pump which is capable of maintaining a practically constant duration of injection regardless of fuel quantity delivered.

An object of the invention is to provide a new and improved fuel injection apparatus adapted to pump and distribute fuel to a plurality of combustion chambers and which is relatively simple and inexpensive in construction and capable of maintaining a practically constant duration of injection regardless of fuel quantity delivered and which will provide accurate distribution of the fuel to each of the combustion chambers.

Another object of the invention is to provide a new and improved fuel injection apparatus having means for controlling residual pressure.

Another object of the invention is to provide a fuel pumping and distributing apparatus in which the same delivery valve is utilized for each of the outlets or discharge lines and which apparatus is provided with a controlled bypass or spill means which is common to all of the outlets.

Another object of the invention is to provide a new and improved bypass or spill control means for fuel injection apparatus and which is relatively simple and inexpensive in construction and efficient in operation.

Another object of the invention is to provide fuel injection apparatus of the type set forth with means for controlling the timing of injection.

Another object of the invention is to provide a new and improved fuel injection apparatus of the type set forth in which the pumping mechanism has a constant effective stroke and wherein means is provided for varying the rate of delivery or injection during the stroke, whereby the pump will maintain a constant injection duration regardless of the fuel quantity delivered.

Other objects and advantages of the invention will be apparent from the following description taken in connection with the accompanying drawings. It will be understood that changes may be made in the details of construction and arrangement of parts, as the preferred forms have been given by way of illustration only.

With fuel injection apparatus previously employed, the quantity of fuel injected was controlled either by a metering valve or throttled inlet arrangement which controlled the quantity of fuel reaching the pumping bore, or where the spill or bypass type of fuel quantity control was employed, the arrangements used provided for spilling only at the end of the stroke and, therefore, with such apparatus the effective stroke of the pumping plunger was varied in all instances thereby making impossible the obtaining of a constant duration of injection regardless of the fuel quantity, and it is therefore the principal object of this invention to provide new and improved means whereby it is possible to obtain constant duration of injection regardless of fuel quantity injected.

Referring to the drawings:

2

Fig. 1 is a longitudinal sectional view of one form of fuel injection apparatus embodying the invention;

Fig. 2 is a sectional view of the hydraulic head of a fuel injection pump but showing a slightly modified form of the invention;

Fig. 3 is a sectional view similar to Fig. 2 with the addition of means for controlling the timing of injection;

Fig. 4 is a graph showing the typical rate of discharge diagrams for varying fuel quantity by varying the effective plunger stroke; and

Fig. 5 is a graph showing the typical rate of discharge diagrams for varying the fuel quantity by means of the apparatus of the present invention.

Referring more particularly to the drawings wherein similar reference characters designate corresponding parts throughout, the apparatus shown in Fig. 1 comprises the fuel injection pump 10 and governor 11 secured together to form a single relatively small compact unit which may be mounted on or removed from the engine as a single unit. If desired, the fuel supply pump which may be a conventional gear type supply pump or other desired form of such pump, may be secured as a part of such unit as shown in Patent 2,518,473 or, if desired, the fuel supply pump may be formed as a separate unit having the fuel supply line connected to the fuel injection pump for supplying fuel thereto.

The fuel injection pump 10 is adapted to be operated by the cam 12 on camshaft 13, which camshaft is adapted to operate at half engine speed or at engine speed, and the number of cam lobes included in cam 12 being dependent upon the speed at which the camshaft is to be operated.

The camshaft 13 is mounted for rotation on ball bearing 14 and bearing 15 adjacent its opposite ends and the camshaft is provided with the usual mounting flange for operatively connecting the pump assembly to the engine.

The fuel injection pump 10 and governor 11 are generally similar to that shown and described in said Patent 2,518,473, except for the hydraulic head as hereinafter described and reference is hereby made to said Patent 2,518,473 for further description of the details of said injection pump and governor.

On the camshaft 13 is provided the helical gear 16 which is rotated by camshaft 13 upon rotation of the camshaft and said helical gear 16 meshes with helical gear 17 on shaft 18 for effecting rotation of the pumping and distributing member of plunger 19 of the hydraulic head 20.

Hydraulic head 20 is provided with a bore 21 adapted to receive pumping and distributing member or plunger 19 and said plunger 19 is adapted to be reciprocated by cam 12 through tappet 22 to which the adjacent end of said plunger 19 is secured by means of spring seat 23, which is retained in engagement with the end of plunger 19 by spring 24 and rotation of said pumping and distributing member or plunger 19 is effected through a gear meshing with gear 16 driving a shaft on which is a gear adapted to mesh with and rotate gear 25, which is keyed to plunger 19 and adapted to rotate the same upon rotation of said gear 25 in a manner similar to that disclosed in Patent 2,518,473. Gear 17 drives shaft 18 for driving a supply pump.

Aligned with bore 21 in hydraulic head 20 is provided delivery valve 26 which communicates with said bore 21 through port 27 which is normally closed by piston or valve member 28 which in turn is normally retained in closed position by valve spring 29.

The hydraulic head 20 is provided with the fuel inlet and spill port 30 which is adapted to be connected to the fuel supply pump by a hydraulic line, not shown, and is adapted to supply fuel through port 31 to bore 21 and

fuel is adapted to be spilled or bypassed back to port 31 through port 32 and annular peripheral groove 33 in plunger 19.

It will be seen from the foregoing that the pump is of constant effective stroke.

Fuel passing through delivery valve 26 passes through ducts 34 and 35 to the annular peripheral groove 36 on plunger 19 which groove 36 communicates with distributing groove 37 adapted to be aligned with the discharge passages 80 in the hydraulic head communicating with each of the outlets 38a successively to thereby provide fuel to each of the combustion chambers in desired sequence.

While the injection duration is constant, the quantity of fuel injected is controlled by the bypass or spill controlled valve 38 which, as shown in Fig. 1, communicates with ducts 34 and 35 and is variable by means of lever 39 and valve 38 is normally retained in closed position by spring 40, which allows automatic opening of the valve when the pressure in ducts 34 and 35 is sufficient to overcome the force of spring 40 to allow the bypassing or spilling of fuel and thereby control the residual pressure in the fuel delivery line. The adjusting lift of valve 38 through lever 39 also adjusts the quantity of fuel bypassed or spilled and, therefore, controls the quantity of fuel delivered by the pump to each of the outlets 38a and thereby to the combustion chambers.

The fuel bypassed or spilled by valve 38 passes through duct 41 to sump 42 which also serves to collect any fuel escaping past the plunger 19 and said fuel is delivered through duct 43 from sump 42 to fuel inlet 30.

In the forms shown in Figs. 1, 2 and 3, the bypass or spill control valve communicates with the fuel path between the delivery valve 26 and the fuel distributor.

In the forms of the invention shown in Figs. 2 and 3, the bypass or spill control valve 38 is positioned above delivery valve 26 and communicates therewith by means of port 44 which allows the passage of bypassed fuel into bypass chamber 45 from which it is returned by duct 46 to fuel inlet 30.

In the form of the invention shown in Fig. 3, the plunger 19 is provided with passage 47 communicating through port 48 with chamber 49, and the passage of fuel through port 48 is controlled by sleeve 50 through eccentric 51 and control lever 52 to thereby control the timing of injection by the pump.

It is pointed out that with the form of the invention shown in Figs. 1, 2 and 3, that it is not necessary that the delivery valve be provided with the retraction piston, as the bypass control valve serves also to effect constant residual pressure in the fuel delivery lines, that is, the bypass valve allows the escape of pressure surges above desired pressure and thereby allows control of the residual pressure in the fuel delivery lines.

This elimination of the retraction piston on the delivery valve has an additional advantage in that the use of such piston limits the speed of operation of the pump and by the elimination of such piston, the speed of the pump can be increased.

The main function of the bypass valve is to control the quantity of fuel injected and allow the obtaining of constant injection duration regardless of quantity injected.

In Figs. 4 and 5, this is graphically illustrated.

In Fig. 4, there is shown the variation in the rates of discharge for varying fuel quantity by the prior art method of varying the effective plunger stroke, whereas in Fig. 5, there is shown typical rate of discharge diagrams for varying the fuel quantity by varying the amount of fuel spilled or bypassed throughout a constant effective plunger stroke.

As will be seen from Fig. 4, with the prior art method there is obtained a fairly constant maximum rate of discharge for each of the different loads and the duration of injection becomes unduly short at low loads which

results in rough running of the engine with consequent high torque variations under these conditions, whereas with the present method as shown in Fig. 5, the duration of injection is practically as long at part loads as at full loads and the peak rates of discharge decrease as the load is decreased, thus, the torque reactions are proportionally less at lighter loads, including idling and engine operation is correspondingly smoother under these conditions.

The governor 3 is positioned within the casing 60 which is secured to the main pump housing by means of the bolts 61 or other suitable means.

The governor shaft 62 is keyed to the camshaft 13 and adapted to rotate therewith.

The governor shaft 62 has a serrated portion 63 and a spider 64 is rigidly mounted upon the serrated portion 63 of the shaft 62. The spider 64 supports the governor weights 65 which are pivotally mounted thereon and each of the weights has a portion which contacts with the flange 66 on sleeve 67 through the ball bearing 68. The sleeve 67 is mounted for longitudinal movement upon the governor shaft 62 and at its opposite end from the flange 66 is provided with the flanges 69 and 70 forming seats for the springs 71 and 72 respectively.

A governor lever 73 is provided in the form of a yoke 74, the forks of which extend around the governor shaft 62 and each fork is pivotally mounted on the lever 75 which is pivotally mounted on the housing 60. Lever 73 pivots also on flange 70.

The governor lever 73 is provided with the cam 76 which is adapted to engage the plate 77 which is so adjusted that the cam 76 just touches this plate 77 at full speed and full load.

Governor lever 73 is connected through suitable linkage to lever 39 for controlling the position of lever 39 according to the governor movement. The link 81 is connected to extension 73b of governor lever 73 which extension is connected to lever 73 at 73a and said link 81 is connected to bell crank 83 which is carried by bracket 82 and is connected to lever 39 for actuating the same.

The spring member 78 and adjustable surge screw 79 are provided for steadying engine performance in case of any surging.

In operation the fuel pump by the pumping member 19 is the same on each pumping stroke, that is, the device has constant effective stroke and the rate of delivery or injection is varied by controlling the amount of fuel spilled or bypassed by valve 38 and, therefore, instead of spilling only at the end of the stroke as with the prior art type of pumps, a little of the fuel is spilled all during the injection which reduces the quantity injected by the amount spilled and maintains a constant injection duration throughout the entire load range.

It will also be noted that as the apparatus utilizes the same delivery valve and spill control for injection through all of the outlets, that the injection through all of the outlets will be precisely the same.

From the foregoing, it will be seen that I have simple, efficient and economical means for obtaining all of the objects and advantages of the invention.

I claim:

1. In a device of the character described, a housing having a bore, a fuel supply port communicating with said bore for supplying fuel thereto, a pumping and distributing member mounted for reciprocation and rotation in said bore, a plurality of outlets communicating with said bore and adapted to receive fuel therefrom, a fuel path between the pumping and distributing portions of said pumping and distributing member, a delivery valve in said fuel path, a bypass fuel passage communicating with said fuel path between said delivery valve and said distributing portion of said pumping and distributing member, said bypass fuel passage communicating with said fuel supply port, and adjustable valve means for controlling the passage of fuel through said bypass passage to said fuel supply port and thereby controlling the fuel

5

quantity delivered to said outlets, said adjustable valve means being biased to closed position by means exerting a variable force, and opened by pressure in said fuel path whereby a practically constant duration of injection will be maintained regardless of fuel quantity.

2. In a device of the character described, a housing having a bore, a fuel supply port communicating with said bore for supplying fuel thereto, a pumping and distributing member mounted for reciprocation and rotation in said bore and having a distributing slot in its periphery, a plurality of outlets communicating with said bore and adapted to receive fuel therefrom, a fuel path externally of said bore between the pumping and distributing portions of said pumping and distributing member, a delivery valve in said fuel path, a bypass fuel passage communicating with said fuel path between said delivery valve and said distributing portion of said pumping and distributing member, said bypass fuel passage communicating with said fuel supply port, and adjustable valve

6

means for controlling the passage of fuel through said bypass passage to said fuel supply port and thereby controlling the fuel quantity delivered to said outlets, said adjustable valve means being biased to closed position by means exerting a variable force, and opened by pressure in said fuel path whereby a practically constant duration of injection will be maintained regardless of fuel quantity.

References Cited in the file of this patent

UNITED STATES PATENTS

2,391,174	Lownsbey	Dec. 18, 1945
2,470,583	Sedgwick	May 17, 1949
2,518,473	Hogeman et al.	Aug. 15, 1950
2,593,788	Parsons	Apr. 22, 1952
2,657,631	Evans	Nov. 3, 1953
2,667,840	High	Feb. 2, 1954