Oct. 24, 1967 G. D. WOLFF 3,348,488

DISTRIBUTOR FUEL INJECTION PUMP WITH PRECHARGING AND PILOT INJECTION

Filed Dec. 7, 1965

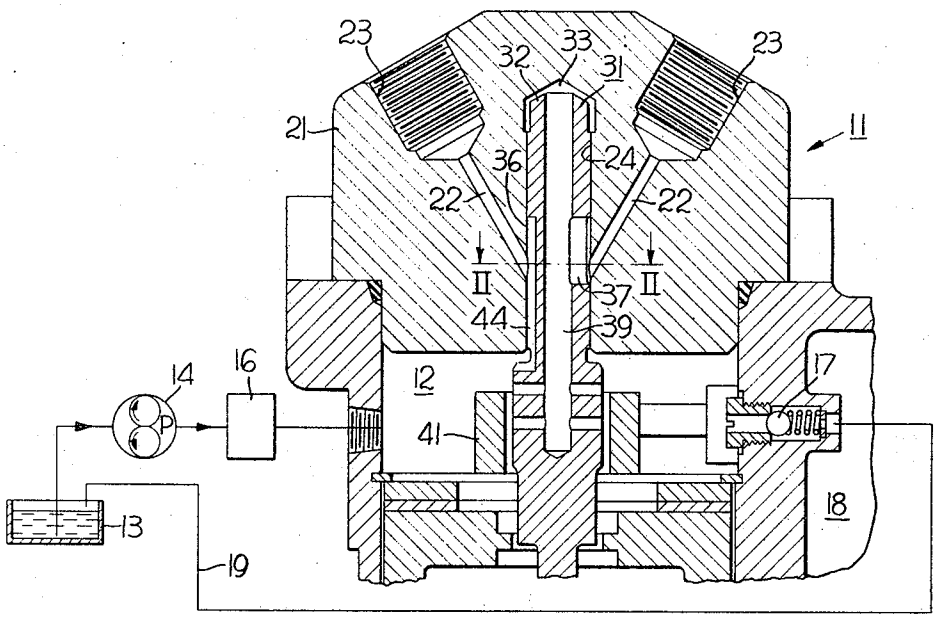

Fig. 1

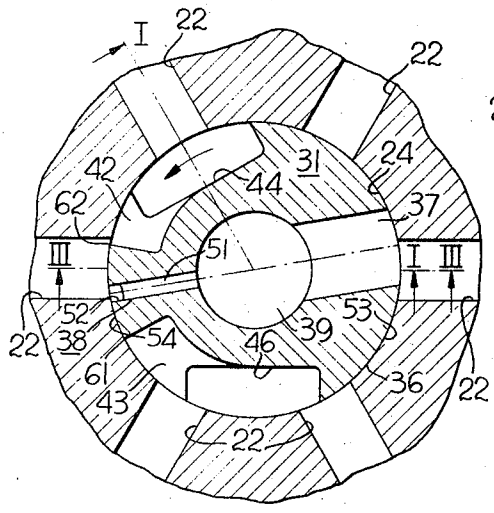

Fig. 2

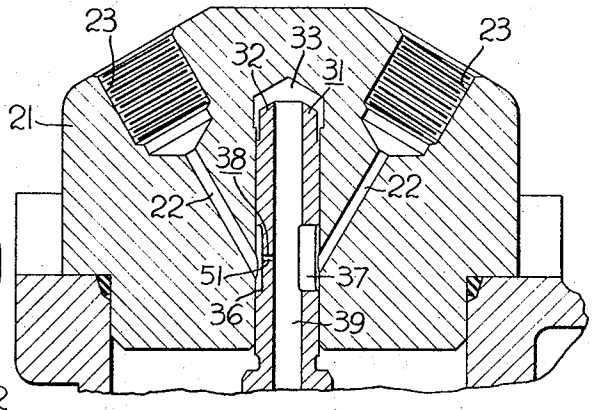

Fig. 3

Inventor
George D. Wolff
By Clark L. Schmidt
Attorney

United States Patent Office 3,348,488 Patented Oct. 24, 1967

3,348,488

DISTRIBUTOR FUEL INJECTION PUMP WITH PRECHARGING AND PILOT INJECTION

George D. Wolff, Hazel Crest, Ill., assignor to Allis-Chalmers Manufacturing Company, Milwaukee, Wis.

Filed Dec. 7, 1965, Ser. No. 512,092
7 Claims. (Cl. 103—2)

ABSTRACT OF THE DISCLOSURE

A precharged fuel injection pump providing pilot and main injection.

This invention relates to a fuel injection pump of the distributor type and particularly to a pump providing both precharging and pilot injection.

In my copending United States patent application Ser. No. 405,189, Precharged Fuel Injection Pump, now abandoned, I described a distributor type fuel injection pump which precharges the fuel delivery lines between injection at supply chamber pressure to achieve improved fuel delivery. In providing pilot injection in a distributor type pump with precharging I conceived of arranging the precharging means so as to effect precharging of the delivery passages in the time interval between pilot injection and main injection and also in the time interval between main injection and pilot injection. Thus, in the preferred embodiment of my invention, both pilot injection and main injection obtain the benefits of precharging.

It is an object of this invention to provide pilot injection in a distributor type pump which precharges the delivery passages at the supply chamber pressure during a substantial portion of the time the delivery passages are not employed to deliver fuel to the injectors.

It is a further object of this invention to obtain the advantages of precharging for both main and pilot injection thereby substantially eliminating the irregularities heretofore experienced in pilot injection systems.

Heretofore in distributor type fuel pumps employing a delivery valve, the delivery valve retraction tailored to achieve a desired main injection and the pilot injection through the same delivery valve was difficult to satisfactorily control, particularly as to the ending of the pilot injection. It is therefore a further object of this invention to obviate this difficulty.

These and other objects of this invention will be apparent when the following description is read in conjunction with the drawings in which.

FIG. 1 is a section view of a fuel injection pump incorporating this invention taken along the line I—I of FIG. 2;

FIG. 2 is a section view taken along the line II—II in FIG. 1; and

FIG. 3 is a section view taken along the line III—III in FIG. 2.

Referring to the drawings, the fuel injection system in which the present invention is incorporated includes a distributor type pump **11** having a supply chamber **12** to which fuel is delivered from a fuel tank **13** by a pump **14** through a filter **16**. Fuel in the supply chamber **12** of the pump housing **21** is maintained at an intermediate pressure such as 50 pounds per square inch by a pressure regulating valve **17** intermediate the supply chamber **12** and the governor chamber **18**. The governor chamber **18** is connected in free flow fluid communication with the supply tank by a fuel line indicated schematically by line **19**. The housing **21** of the fuel pump **11** includes a bore **24** opening at one end into supply chamber **12** and a plurality of delivery passages **22** adapted by threaded openings **23** for connection to fuel lines leading to injectors at the cylinders of a compression ignition engine. The

delivery passages **22** open into bore **24** at equally spaced circumferential intervals as shown in FIG. 2.

The pump plunger **31** is reciprocated and rotated in a conventional manner to cyclically deliver fuel under pressure to the delivery passages **22**. The plunger **31** has a pumping portion **32** disposed in a high pressure chamber **33** at the end of bore **24**, a fluid receiving and controlling portion **33** disposed in the supply chamber **12** and a distributing portion **36** disposed in bore **24** adapted to cyclically connect the high pressure chamber **33** to the delivery passages **22** by way of main delivery port **37** and pilot delivery port **38**. The central fuel supply passage **39** in plunger **31** not only serves to supply fuel from the supply chamber **12** to the high pressure chamber **33**, but also serves to connect the high pressure chamber to delivery ports **37** and **38**. As explained in my beforementioned copending patent application, Ser. No. 405,189, Precharged Fuel Injection Pump, the control sleeve **41** cooperates with the plunger **31** to determine the effective stroke of the plunger and the timing of fuel delivery to the delivery passages **22**.

In the distributor portion **36** of the plunger **31**, which portion may be considered to be valve means, a pair of radially opposite precharging recesses **42, 43** are provided which are connected in free flow fluid communication with the supply chamber **12** by axially extending grooves **44, 46**. The recesses **42, 43** and grooves **44, 46** form passageways cyclically registrable with the delivery passages **22** as the plunger **31** is rotated, to effect equalizing of pressure in the delivery passages **22** to that in the supply chamber between intervals when the delivery passages **22** are being employed to effect pilot or main quantity injection.

The pilot delivery port **38** includes a restricted radial opening or bore **51** and an axially extending recess **52** at the periphery of the plunger diametrically opposite to the main port **37**. The amount of fuel delivery by way of pilot port **38** is substantially less than fuel delivery by way of main port **37**. By providing a pair of radially opposite precharging passageways in the valve or distributing portion **36** of the plunger **31** and by providing main and pilot ports **37, 38** opening on the plunger periphery at peripheral lands **53, 54**, respectively, I have created a precharged, distributor type injection pump with pilot injection which is inexpensive and requires no parts in addition to the fuel injection pump described in my beforementioned pending patent application.

In the position shown in FIG. 2, the delivery passage registering with main port **37** has just received the main injection and the plunger **31** is at about top dead center, as shown in FIG. 1. Also as shown in FIG. 2, the pilot port **38** has completed delivery of a small quantity of fuel to the delivery passage with which it registers, and such passage is in communication with precharging recess **42**. As the plunger rotates, each delivery passage is sequentially and cyclically connected to main port **37**, precharging recess **43**, pilot port **38** and precharging recess **42**.

My invention is particularly useful in four cycle engines and when so employed, the pilot injection occurs at the time the exhaust valves are closing, at which time the intake valves have just opened. In other words pilot injection occurs at the beginning of the intake stroke. In my illustrated pump design, a delivery valve is not used and thus the usual delivery valve retraction problems are avoided. Heretofore, the ending of pilot injection, through a delivery valve designed for proper main injection characteristics, was not satisfactory and irregularity in pilot injection quantity was a problem. Precharging prior to both main and pilot injection in accordance with my present invention eleminates irregularities in both pilot and main injection.

The pilot opening **51** may be sized to properly propor-

tion the pilot delivery to main delivery. Different engines may require different pilot quantities and the opening **51** may be proportioned accordingly.

It will be noted that pilot injection can only take place during the time that land **54** is covering the delivery passage **22**. Pilot injection will not commence prior to edge **61** of land **54** passing by the opening **22** and will continue only until edge **62** of land **54** exposes passage **22** to recess **42**. Therefore the duration of the pilot injection will be independent of the main injection above a quantity predetermined by the circumferential distance between edges **61** and **62**. Since the passage **51** acts as the restriction for the pilot injection, main injection is essentially unaffected by the establishment of communication between opening **51** and recess **42** by way of registering passage **22**.

The embodiments of the invention for which an exclusive property or privilege is claimed are defined as follows:

1. In a distributor type fuel injection pump the combination comprising:

a pump housing including

a bore,

a plurality of delivery passages communicating at angularly spaced intervals with said bore adapted for connection to fuel delivery lines, respectively,

an injection pressure chamber at one end of said bore, and

a supply chamber for supplying fuel to said injection pressure chamber,

means supplying fuel to said supply chamber and maintaining the latter at a pressure substantially above atmospheric pressure,

a reciprocable pump plunger in said bore for pressurizing fuel in said injection pressure chamber, and

rotating valve means in said housing between said injection pressure chamber and said delivery passages defining a pilot port and a main port cyclically connecting said delivery passages two at a time to said injection pressure chamber during the pumping stroke of said plunger to deliver a main quantity of fuel through said main port to one of said two passages and a relatively smaller quantity of fuel through said pilot port to the other of said two passages and defining precharging passage means cyclically connecting said delivery passages in free flow fluid communication with said supply chamber during a major portion of the time they are disconnected from said injection pressure chamber.

2. The pump set forth in claim **1** wherein said bore opens at its other end into said supply chamber, wherein said pump plunger is rotatable and wherein said rotating valve means includes a valve portion formed on said pump plunger and disposed between said injection pressure chamber and said supply chamber.

3. The pump set forth in claim **2** wherein said valve portion includes a main delivery port and a smaller pilot delivery port circumferentially spaced from one another

and opening on the periphery thereof and passage means placing said ports in fluid communication with said injection pressure chamber.

4. The pump set forth in claim **3** wherein said valve portion includes a pair of radially opposite precharging recesses circumferentially intermediate said ports and cyclically registrable with said delivery passages and further comprising means placing said recesses in free flow fluid communication with said supply chamber.

5. A fuel injection pump for a four cycle engine comprising:

a housing including

a high pressure chamber,

a supply chamber,

a bore extending between said chambers, and

a plurality of delivery passages opening into said bore between said chambers and at equally spaced circumferential intervals,

means maintaining said supply chamber at an intermediate pressure,

a rotatable and reciprocable pump plunger in said bore having

a radially opening main port cyclically registrable with said passages one at a time during rotating of said plunger,

a radially opening pilot port spaced circumferentially from said main port and cyclically registrable with said passages one at a time during rotation of said plunger,

means connecting said ports in fluid receiving relation to said high pressure chamber, and

means connecting said delivery passages to said supply chamber during a portion of the time they are out of registry with said ports including a passageway in said plunger opening on the periphery thereof between said ports and cyclically registrable with said delivery passages, said portion of time being greater than the time required for one of said ports to rotate through one of said circumferential intervals.

6. The pump set forth in claim **5** wherein, during rotation of said plunger, said passageway connects said delivery passages to said supply chamber between their registration with said pilot and main ports.

7. The pump set forth in claim **5** wherein said means connecting said delivery passages to said supply chamber further includes a second passageway in said plunger cyclically registrable with said delivery passages, said passageways being circumferentially on opposite sides of said ports so as to effect precharging of said delivery passages at said intermediate pressure prior to registration with said pilot and main ports during operation of said pump.

References Cited

UNITED STATES PATENTS

2,544,561	3/1951	Meyer	103—154
2,871,796	2/1959	Dreisin et al.	123—32.61

LAURENCE M. GOODRIDGE, *Primary Examiner.*