Aug. 13, 1940. A. J. DAVIDSON, JR 2,211,496

INJECTOR NOZZLE

Filed June 15, 1939

Fig. 1.

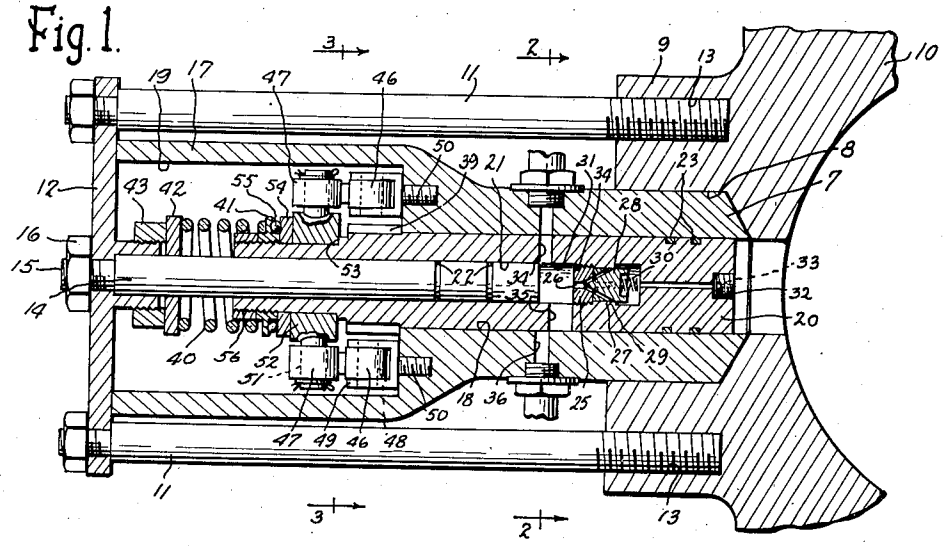
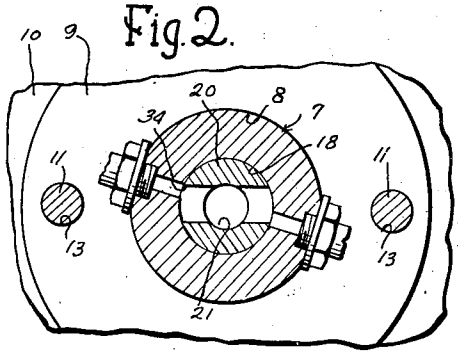


Fig. 2.



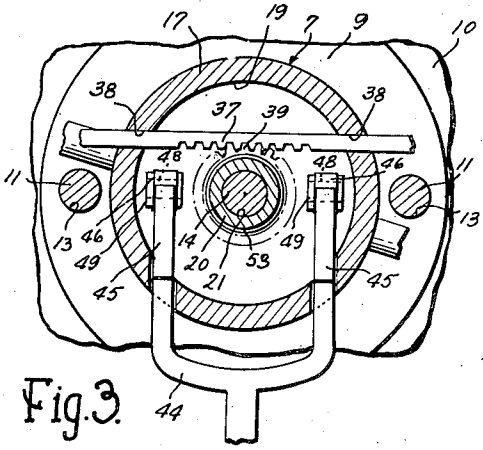


Fig. 3.

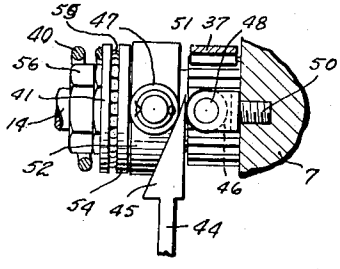


Fig. 4.

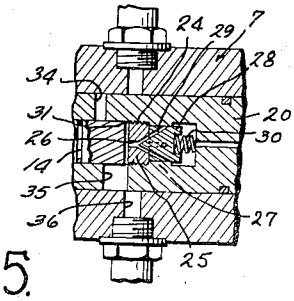
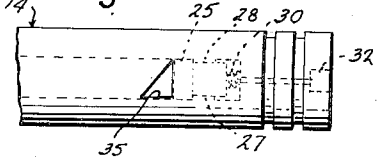


Fig. 5.

Fig. 6.



INVENTOR.
Andrew J. Davidson Jr.

BY Edward M. Apple

ATTORNEY.

Patented Aug. 13, 1940 2,211,496

# UNITED STATES PATENT OFFICE

2,211,496

## INJECTOR NOZZLE

Andrew J. Davidson, Jr., Detroit, Mich.

Application June 15, 1939, Serial No. 279,292

6 Claims. (Cl. 103—41)

This invention relates to fuel injectors for internal combustion engines, and has particular reference to an improved unitary injector, such as disclosed in my copending application, S. N. 162,185, filed Sept. 2, 1937.

The principal object of this invention is to generally improve fuel injectors of the character referred to.

Another object of the present invention is to provide a simplified control for the by-passing of fuel through the nozzle.

Another object of the invention is to simplify the structure described in my copending application, referred to above, so that the device may be more easily assembled and taken apart for inspection.

Further objects and advantages of the invention will appear as the description proceeds, reference being made, from time to time, to the accompanying drawing, in which:

Fig. 1 is a longitudinal section taken through a device embodying my present invention. This view illustrates the relative position of the various parts at the beginning of an injection stroke.

Fig. 2 is a vertical section taken substantially on the line 2—2 of Fig. 1.

Fig. 3 is a vertical section taken substantially on the line 3—3 of Fig. 1.

Fig. 4 is an enlarged fragmentary detail illustrating the roller and wedge assembly for moving the plunger.

Fig. 5 is an enlarged fragmentary detail in section, which illustrates the relation of the various parts upon the completion of the injection stroke.

Fig. 6 is an enlarged fragmentary detail of a portion of the plunger, illustrating the relation of the delivery valve assembly and the by-pass port.

Referring now more particularly to the drawing, it will be understood that the device embodying my present invention consists of a cylindrical body member 7, which may be made of any suitable material, and machined to tightly fit into a recess 8, bored in a boss 9 formed on the side of the cylinder block of an engine; a fragmentary portion of which is indicated by the reference character 10.

The body 7 is preferably secured in position by means of bolts 11, which extend through the end plate 12, and into internally threaded recesses 13 formed in the boss 9. The end plate 12 is adapted to serve as a closure element for one end of the body 7 and is arranged to support the core 14, the latter being secured thereto by means of an externally threaded portion 15 and a nut 16. The body 7 is bored as at 18, and counter-bored, as as 19, in which bores are positioned the working parts of my device.

A plunger 20 is mounted for reciprocation in the bore 18. The plunger 20 is provided with an internal bore 21, which is adapted to accommodate the fixed core 14. The core 14 is provided with compression rings 22, and the plunger 20 is provided with compression rings 23, to provide against leaks.

The internal bore 21 is threaded, as at 24, and is arranged to receive a threaded plug 25, which in turn, is provided with an internal passage-way 26. Between the plug 25 and the end of the bore 21 is a restricted area 27, in which is slidably mounted a delivery valve 28. The valve 28 is provided with angularly positioned passage-ways 29, which are arranged to communicate with the passage-way 26 in the plug 25. A compression spring 30 is arranged to normally maintain the valve 28 in a closed position, as shown in Fig. 1. The compression of this spring must be sufficient to allow a predetermined pressure to be built up in chamber 31, which is formed between the end of the core 14 and the plug 25. The greater the pressure in chamber 31, the better the fuel will be atomized during delivery. A burner plate 32 is threadedly mounted in an internally threaded recess formed in the end of the plunger 20, and has a small axial passage-way 33, arranged to communicate with a similar, but larger in diameter, axial passage-way formed in the plunger 20. The compression chamber 31 communicates at one side with a passage-way 34, which extends through the plunger 20 and the body 7, and which in turn is connected to a fuel transfer pump (not shown) which moves the fuel from the main fuel tank. That part of the passage-way 34, which is in the plunger 20, is in the form of an arcuate slot, so that there is always communication with that part of the passage-way 34, formed in the body 7, no matter to what position the plunger 20 is rotated. The other side of the compression chamber 31 communicates with a triangular shaped port 35 (Fig. 6) formed in the plunger barrel 20, which is adapted to communicate with the passage-way 36 which extends through the body 7 and is connected to the fuel tank, as hereinafter described.

In order to control the amount of fuel to be by-passed from the compression chamber 31, I provide an improved control means, which I will now describe. In order to more effectively control the by-passing of the fuel from the compression chamber 31, I provide for the ro-

tation, on its longitudinal axis, of the plunger 20 through an arc sufficient to open and close the port 35. This rotation is accomplished by means of the rack and pinion illustrated in Fig. 3. The rack 37 is slidably supported by suitable apertures 38, formed in the enlarged portion 17 of the body member 7. The pinion 39 is press-fitted on to the plunger barrel 20. The rack 37 is connected to manually operable means (not shown), and as the rack 37 is moved, it causes the rotation of the plunger 20, corresponding to the degree of the movement.

The plunger 20 is normally held in the position illustrated in Fig. 1, by means of the compression spring 40, which is mounted around the core 14 and abuts at either end against the retaining elements 41 and 42. Adjustment is made in the compression of the spring 40 by means of the adjusting screw 43, and threadedly engages a suitable boss formed on the inside of the end plate 12.

The movement of the plunger 20 away from the engine block is accomplished by the means which are now described. I provide a yoke 44 (Fig. 3), upon the end of each arm of which is a wedge shaped member 45 adapted to be inserted between two sets of rollers 46 and 47, arranged as shown in Figs. 1 and 4. The rollers 46 are mounted on axles 48, which are journaled in bearing members 49, which are secured to the body member 7 by suitable screws 50. The rollers 47 are supported on axles 51 formed on the ring 52, which is freely mounted on a reduced section of the plunger 20. The ring 52 is retained on one side by the shoulder 53, and on the other side by a retainer 54, the latter being grooved to accommodate ball bearings 55. The retaining element 41 is held in predetermined position by means of the lock member 56.

The yoke 44 is mounted at the end of a push rod, which is adapted to be actuated by a suitable timed cam (not shown), which is mounted on the engine to which the device is attached. The wedge shaped elements 45, when moved by the push rod, cause the rollers 47 to separate from the rollers 46, thereby causing the plunger 20 to be moved against the compression of the spring 40. It will be understood that the cam accommodating the wedge 45, is timed to operate, and causes the plunger 20 to start to move away from the combustion chamber of the engine as the compression reaches its maximum in the cylinder of the engine. The compression in the spring 40 will be adjusted so that it will just overcome the maximum compression pressure in the combustion chamber of the engine cylinder, so as to normally hold the plunger 20 in the position as shown in Fig. 1.

The operating cycle of my device is as follows: Fuel is pumped to the device by means of the usual transfer pump (not shown) where it enters the passageway 34 and through which it travels to the compression chamber 31. As the plunger 20 is moved away from the engine, under the influence of the properly timed cam operated wedges 45, the fuel in the compression chamber 31 can only escape in two directions; either through the by-pass port 35 into the passage-way 36 and hence to the fuel tank or supply line, or through the axial passage-way 26, formed in the plug 25 and through the angular passage-ways 29, formed in the valve 28 and into the space between the valve 28 and the end of the bore 21, and hence through the axial passage-way in the plunger 20, and the burner plate 32 and into the combustion chamber of the engine. By rotating the plunger 20, the by-pass clearance between the port 35 and the by-pass outlet 36, is either increased or diminished. As the by-pass clearance is decreased, there is an increased amount of fuel injected through the valve 28 into the engine; and as the by-pass clearance is increased, there is a decreased amount of fuel forced through the valve 28 into the engine. As illustrated in Fig. 5, I prefer, at all times, to maintain a slight by-pass between the port 35 into the passage-way 36, so as to release the pressure back of the discharge valve 28 at the finish of an injection stroke.

As the plunger 20 is moved away from the engine, the first part of the stroke is ineffective to discharge oil past the valve 28, for in this position the by-pass port 35 is open and the fuel will be by-passed through the passage-way 36. As the plunger 20 continues its movement away from the engine, the by-pass will be reduced, thereby building up pressure in the chamber 31. While the by-pass port 35 remains open, the outlet ports of the angular passage-ways 29 in the valve 28 are still covered by the walls of the restricted area 27. As the plunger 20 continues to move away from the engine, the opening in the by-pass port 35 will be reduced and almost closed, thereby building up pressure in the chamber 31, at which time the unrestricted area of the internal bore of the plunger 20 communicates with the outlet ports of the valve 28, thus permitting the fuel to pass around the end of the valve 28 and hence into the axial passage-way 33, formed in the plunger 20, and hence into the combustion chamber of the engine.

When the plunger 20 reaches the end of its travel away from the engine, which position is shown in Fig. 5, the compression in the chamber 31 is reduced to a minimum, thereby permitting the delivery valve 28 to be returned to its normal position under the influence of the spring 30. In this position it is evident that no more fuel will be discharged into the combustion chamber of the engine, as the walls of the restricted area of the bore 21, close the angular passage-ways 29, in the valve 28. When the plunger 20 reaches the position shown in Fig. 5, it will be returned to the position shown in Fig. 1, by means of the spring 40, and the cycle is completed.

Having described my invention, what I claim and desire to secure by Letters Patent is:

1. In a device of the character described, including a body member having a plunger reciprocable therein, and a compression chamber in said plunger, the combination of an intake passage-way in said body member and said plunger, in communication with the compression chamber in said plunger, and a by-pass port in said plunger communicating with said compression chamber and an outlet line, said by-pass port being arranged to be opened and closed upon the radial movement of said plunger, and means for moving said plunger axially and means for moving said plunger radially, at least a portion of each of said means, being housed within an extension of said body member.

2. In a device of the character described, including a body member having a plunger reciprocable therein, and a compression chamber in said plunger, the combination of an intake passage-way in said body member and said plunger, in communication with the compression chamber in said plunger, and a by-pass port in said

plunger communicating with said compression chamber and an outlet line, said by-pass port being arranged to be opened and closed upon the radial movement of said plunger, means for moving said plunger axially and means for moving said plunger radially, at least a portion of each of said means, being housed within an extension of said body member, and another portion of each of said means extending through the walls of said body member.

3. In a device of the character described, including a body member having a plunger reciprocable therein, and a compression chamber in said plunger, the combination of a fuel intake communicating with said compression chamber, a by-pass port in said plunger arranged to be opened and closed by the radial movement of said plunger, a counter-bore in said body member, and a rack and pinion in said counter-bore, said rack extending through the walls of said body member and said pinion being secured to said plunger.

4. The combination defined in claim 3, including two pairs of rollers within said counter-bore, one pair being secured to said body member and one pair being secured to said plunger, wedge shaped elements arranged to be driven between the said pairs of rollers, and means extending through the walls of said body member and arranged to move said wedge shaped elements.

5. In a device of the character described, including a body member having a cylindrical plunger reciprocable therein, a fixed core telescoped by said plunger, and a compression chamber between the core and one end of said plunger, the combination of a fuel intake communicating with said compression chamber, an angular by-pass port in said plunger communicable with said compression chamber and arranged so that, upon the rotation of said plunger about said fixed core, varying degrees of compression may be established within said compression chamber.

6. The combination defined in claim 5, wherein the plunger is provided with a pinion adapted to engage a control rack, which is directly actuated from without the said body member.

ANDREW J. DAVIDSON, JR.