Jan. 8, 1946. H. F. HAINES 2,392,474

FUEL INJECTOR

Filed Jan. 31, 1944

Fig. 1.

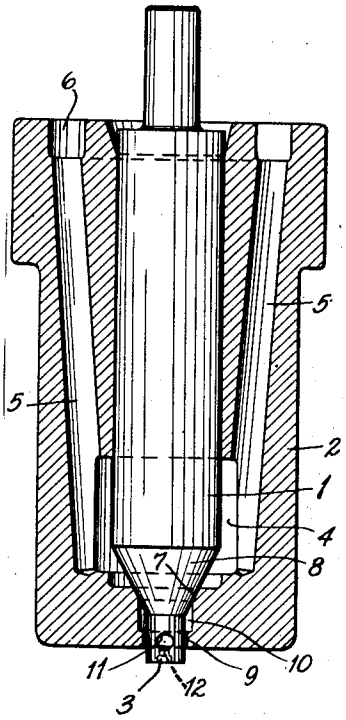



Fig. 2.

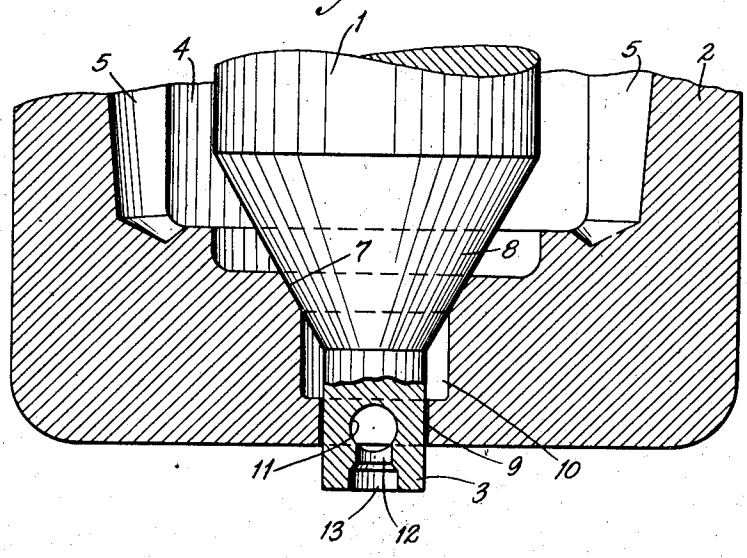



Fig. 3.

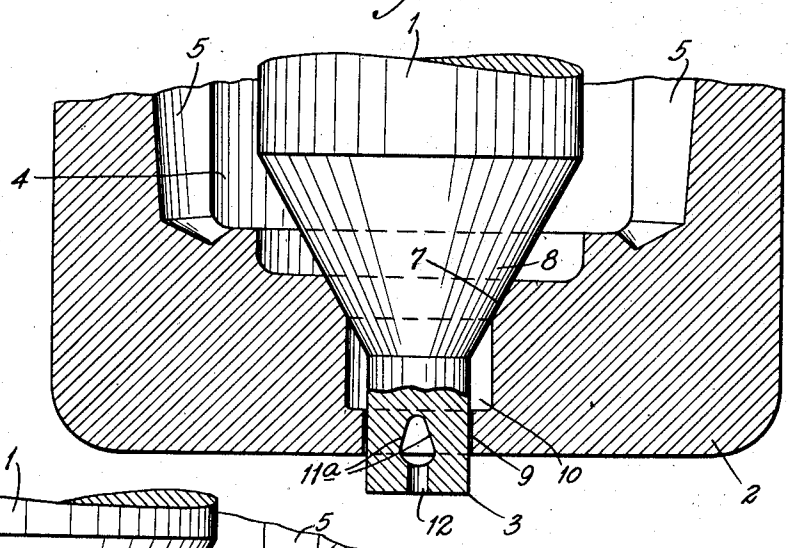
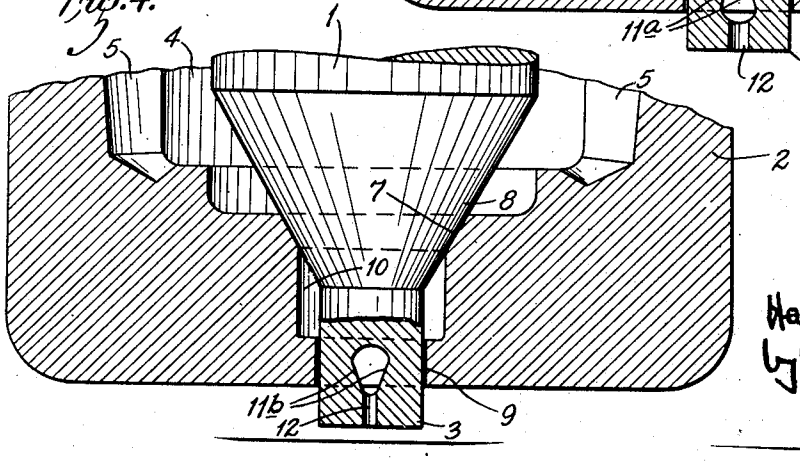



Fig. 4.

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# UNITED STATES PATENT OFFICE

2,392,474

## FUEL INJECTOR

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Application January 31, 1944, Serial No. 520,567

5 Claims. (Cl. 299—107.5)

This invention relates principally to fuel injectors for compression ignition engines, and more particularly to fuel injectors of the type having a valve that is opened hydraulically by the fuel pressure. The invention has for its principal object to devise a simple and economical fuel injector of the above type that will provide a small quantity of finely atomized fuel at the start of injection, followed by delivery of the major part of the fuel in increasing or decreasing quantity, depending on the injection characteristic desired. The invention consists in the fuel injector and in the construction, combinations and arrangements of parts hereinafter described and claimed.

In the accompanying drawing, which forms part of this specification and wherein like symbols refer to like parts wherever they occur,

Fig. 1 is a central longitudinal sectional view of a fuel injector embodying my invention,

Fig. 2 is an enlarged central longitudinal sectional view through the discharge or nozzle end of said injector; and

Figs. 3 and 4 are views similar to Fig. 2, showing two modified forms of the invention.

My fuel injector comprises a cylindrical plunger 1 that is reciprocable in an axial bore provided therefor in a cylindrical nozzle member 2 and terminates at its lower end in a reduced pin or pintle portion 3 that normally projects beyond the lower or discharge end of said nozzle member. The axial bore of the nozzle member 2 has an annular groove therein that cooperates with the plunger 1 to form an annular chamber 4, which is supplied with fuel under pressure through one or more fuel inlet passageways 5 that lead downwardly from an annular fuel inlet groove 6 in the upper or inlet end of said nozzle member and opens into said chamber through the side thereof.

The portion of the axial bore of the nozzle member 2 below the fuel chamber 4 therein is tapered inwardly and downwardly to provide a conical valve seat 7. The plunger has a portion 8 that tapers downwardly from a point above the bottom of the chamber 4 to the pin 3 located therebelow and forms a conical valve element for cooperation with the conical valve seat 7 located between said bottom of said chamber and the lower or discharge end of the plunger supporting bore. The outer or discharge end of the plunger supporting bore of the nozzle 2 is further reduced to form with said plunger an annular primary fuel discharge orifice 9 and an annular fuel chamber 10 between the valve seat 8 and said discharge orifice.

By the arrangement described, the pressure of the fuel in the annular fuel chamber 4 acts on the conical portion 8 of the plunger 1 above the valve seat 7 and forces said plunger upwardly, thereby lifting said conical portion off said valve seat and permitting flow of the fuel into the chamber 10 and the escape of a small quantity of well atomized fuel through the primary annular fuel discharge orifice 9. The fuel pressure then acts on the entire conical portion 8 of the valve plunger 1 to fully open the valve without increasing the quantity of fuel discharge through the annular primary fuel discharge orifice 9.

The primary discharge of fuel through the narrow annular discharge orifice 9 is followed by a discharge of the major part of the fuel through a separate main fuel discharge passageway in the pintle end 3 of the plunger 1. As shown in Figs. 1 and 2, this main fuel discharge passageway comprises a diametral cross bore or passageway 11 in the pin 3 and an axial discharge passageway 12 that leads downwardly from said diametral passageway and opens through the outer or lower end face of said pin. The location of the diametral passageway 11 is such that it is not brought into direct communication with the fuel chamber 10 until after the tapered portion 8 of the plunger 1 is lifted off the valve seat 7 and a small quantity of finely divided fuel has escaped through the primary discharge orifice 9. After this primary discharge of the fuel, continued opening movement of the plunger 1 brings the diametral passageway 11 therein into direct communication with the chamber 10, thus permitting the discharge of the major portion of the fuel injection through the axial discharge passageway 12.

As shown in Fig. 2, the axial fuel discharge passageway 12 in the pin 1 may be counterbored, as at 13, to any desired diameter and depth to vary the shape and power of penetration of the main fuel jet. The cross-sectional shape of the diametral fuel passageway 11 may be changed to vary the quantity of the main fuel injection during the opening lift of the valve. Thus, the passageway may be of circular cross-section, as shown in Fig. 2, or with downwardly diverging side walls 11*a*, as shown in Fig. 3, whereby the cross-section of said passageway is opened gradually as it moves upwardly across the control edge 10*a* formed by the bottom of the fuel chamber 10 and the quantity of fuel discharged from the axial passageway 12 gradually increases during the opening movement of the plunger. In the construction shown in Fig. 4, on the other hand, the diametral passageway has downwardly converging side walls 11*b*, whereby the quantity

of the main fuel injection is a maximum at first, followed by a gradual decrease in fuel delivery as the valve completes its opening movement.

By the arrangement described, the annular space 9 between the pin 3 and the discharge end of the axial bore of the nozzle 2 is opened prior to the main fuel discharge passageway 11, 12 and serves as a primary discharge orifice for idling or for the control of the beginning of the injection when a small quantity of well atomized fuel must lead the main injection for best performance. Continued opening movement of the valve brings the main fuel discharge passageway 11, 12 in the pin or pintle 3 of the plunger 1 into communication with the annular fuel chamber 10, whereby the major portion of the fuel is discharged through the outlet end 12 of said axial discharge passageway. This discharge of the main or major portion of the fuel injection through the axial discharge passageway 12 may be controlled, as shown in Fig. 3, to provide a gradual increase in the quantity of fuel delivery as the valve opens, or, as shown in Fig. 4, to provide a decrease in the fuel quantity delivery as the valve opens. As shown in Fig. 2, the mouth 13 of the axial discharge passageway 12 may be shaped to vary the spray characteristics of the main fuel jet.

What I claim is:

1. A fuel injector comprising a nozzle having a bore opening through the outer end of said nozzle, an inwardly facing valve seat in said bore adjacent to the outer end thereof and a fuel supply passageway opening into said bore inwardly of said valve seat, and a plunger reciprocable in said bore and having a valve element cooperating with said valve seat and portions cooperating with said bore to form therewith an annular fuel discharge orifice at the outer end thereof, and an annular fuel chamber extending from said valve seat to said annular discharge orifice and in continuous communication with the latter, said plunger having a fuel discharge passageway with an inlet end located in the side face of said plunger and a discharge end opening through the outer end thereof, said inlet end of said discharge passageway opening into said annular discharge orifice in the closed position of said valve and being movable inwardly of said annular discharge orifice into direct communication with said annular fuel chamber after an initial discharge of fuel through said annular discharge orifice at the beginning of the valve opening stroke of said plunger.

2. The combination as set forth in claim 1, wherein the width of said inlet end of said discharge passageway is varied in the direction of the plunger axis to vary the quantity of fuel discharged through said discharge passageway after such initial discharge of fuel through said annular discharge orifice.

3. The combination as set forth in claim 1, wherein said inlet end of said discharge passageway increases in width from the inner towards the outer end of said plunger to increase the quantity of fuel discharged from said discharge passageway after such initial discharge of fuel through said annular discharge orifice.

4. The combination as set forth in claim 1, wherein said inlet end of said discharge passageway decreases in width from the inner towards the outer end of said plunger to decrease the quantity of fuel delivered from said discharge passageway after such initial discharge of fuel through said annular discharge orifice.

5. The combination as set forth in claim 1, in which said discharge passageway is enlarged at the discharge end thereof.

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