April 18, 1939. R. D. STREBY 2,154,875

FUEL INJECTOR

Filed May 24, 1937

Fig. 2.

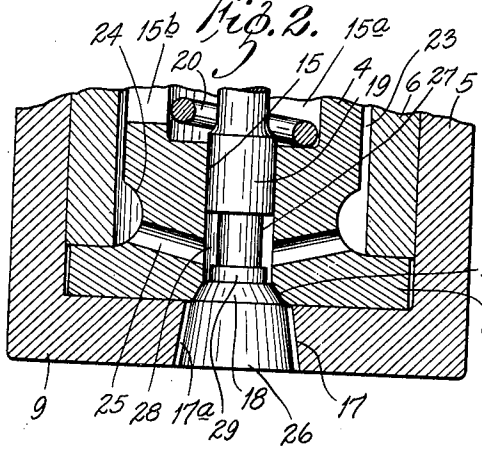


Fig. 1.

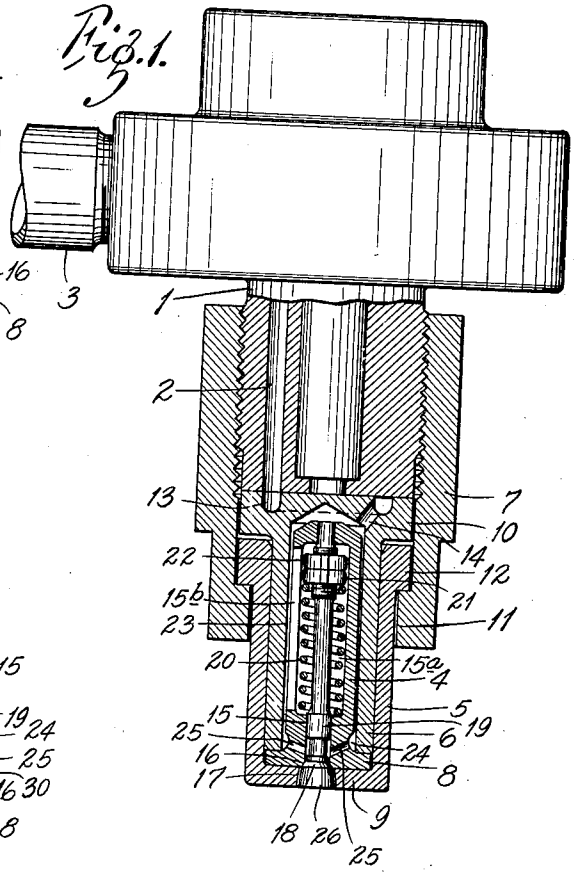


Fig. 3.

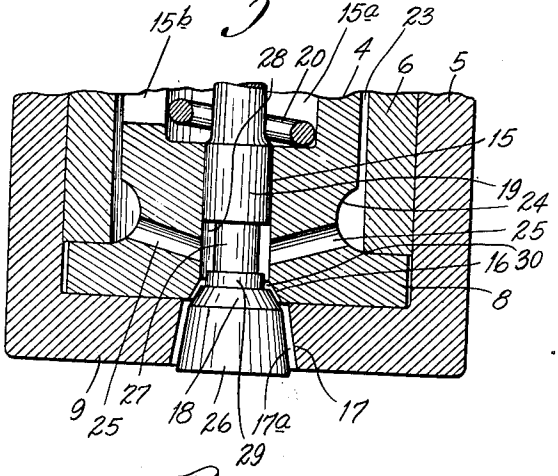


Fig. 4.

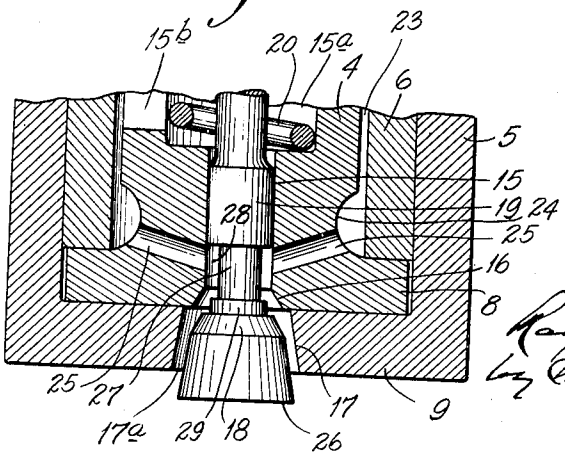
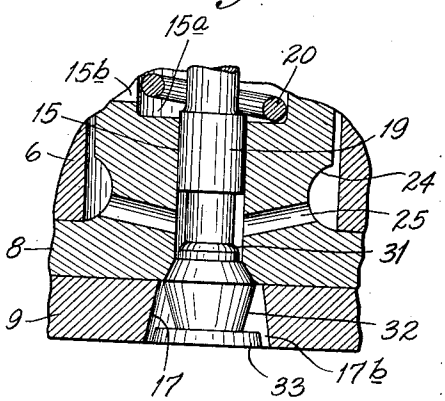


Fig. 5.



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2,154,875

UNITED STATES PATENT OFFICE

2,154,875

FUEL INJECTOR

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8 Claims. (Cl. 299—107.6)

This invention relates to fuel injectors, particularly hydraulically operated fuel injectors for internal combustion engines of the compression-ignition type. Its principal objects are to provide a fuel injector that will deliver a minimum quantity of fuel during the early stages of the injection period and thereby prevent sudden pressure increase in the engine cylinder and consequent heavy running of the engine, that will enable the delivery valve to seat quickly at the end of the injection period and thus prevent after injection or nozzle dribble, and that will embody other advantages hereinafter appearing. 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 part side elevation and part central longitudinal sectional view of a fuel injector embodying my invention,

Fig. 2 is an enlarged central longitudinal sectional view of the outer or discharge end portion of the injector, the valve being shown closed,

Fig. 3 is a similar view with the valve shown partly open,

Fig. 4 is a similar view with the discharge valve shown fully open; and

Fig. 5 is a view similar to Fig. 2 showing a modified construction.

In the accompanying drawing, my invention is shown embodied in a fuel injector for an internal combustion engine of the Diesel type. Said injector comprises a main body portion or holder 1 having an inlet passageway 2 adapted to be supplied by a suitable pipe 3 with fluid fuel under pressure. The holder is provided with a removable nozzle assembly comprising concentric cylindrical inner, outer and intermediate sleeves 4, 5 and 6, respectively, secured together and to said holder by means of a ring nut 7 threaded on the latter.

The inner sleeve 4 is provided at its outer end with an outstanding flange 8 that is clamped between the outer end wall 9 of the outer sleeve 5 and the outer end of the intermediate sleeve 6; and said inner sleeve is provided at its inner end with an outstanding flange 10 that bears flatwise against the outer end of the holder 1. The ring nut 7 is provided at its outer end with an internal flange 11 that bears against an external flange 12 at the inner end of the outer sleeve 5, thereby clamping the intermediate sleeve 6 against the outer end of the holder 1 and the external flange 8 at the outer end of the inner sleeve 4 between the outer end wall 9 of said outer sleeve and the outer end of said intermediate sleeve. The fuel passageway 2 in the holder 1 opens through its nozzle engaging end into an annular groove 13 in the inner end of the intermediate sleeve 6; and this annular groove communicates through one or more inlet ports 14 with the bore of said intermediate sleeve.

The axial bore 15 of the inner sleeve 4 terminates at the outer end thereof in an outwardly flared valve seat 16; and the outer end wall 9 of the outer sleeve 5 is provided with an outwardly flared axial hole 17 that constitutes a continuation of the axial bore 15 of said inner sleeve. Cooperating with the valve seat 16 at the outer end of the bore 15 of the inner sleeve 4 is a conical valve member or element 18 having an inwardly extending stem portion 19 that is slidably supported in said bore. Said bore is enlarged, as at 15a, intermediate its ends to accommodate a spring 20 that surrounds said stem with one end seating against the outer end of the enlarged portion of said bore and with its other end bearing against a nut 21 threaded on said valve stem. A second nut 22 is provided for locking the nut 21 in adjusted position on the valve stem 19. The inner sleeve 4 is provided opposite the enlarged portion 15a of its valve stem supporting bore 15 with a side opening 15b through which the valve closing spring 20 may be inserted and removed. The inner valve or supporting sleeve 4 is of smaller outside diameter than the inside diameter of the intermediate sleeve 6, thereby forming an annular passageway 23 between said sleeves. The valve supporting sleeve 4 is provided just inside of the flange 8 at the outer end thereof with a peripheral groove 24 and one or more radial ports 25 that lead from said groove to the bore of said sleeve.

The valve 18 is provided with an outwardly extending head portion 26 that terminates flush with the outer end of the outer sleeve 5 in the closed position of the valve, is flared outwardly at an angle corresponding to the flared hole 17 in the end wall 9 of said outer sleeve and is of smaller diameter than said hole so as to form therewith an annular discharge orifice 17a. The valve stem 19 is provided inwardly of the valve 18 with an annular groove 27 which, in the closed position of said valve, cooperates with the stem supporting bore 15 of the inner sleeve 4 to form an annular chamber 28 that communicates with the ports 25 leading from the annular groove 24

in said sleeve. The portion 29 of the valve stem 19 between the groove 27 and the valve 18 is of slightly smaller diameter than the stem supporting bore 15, thereby forming an annular passageway 30 between the annular chamber 28 and the annular discharge orifice 26 during the early part of the opening movement of said valve and during the latter part of its closing movement.

The fuel passes through the passageway 2 in the holder 1 into the annular groove 13 in the inner end of the intermediate sleeve 6, thence through the ports 14 therein into the annular passageway 23 between said sleeve and the inner sleeve 4, and thence through the ports 25 in said inner sleeve into the annular chamber 28 where the hydraulic pressure of the fuel operates to force the valve 18 off its seat 16. During the early part of the opening movement of the valve, the fuel flows through the relatively narrow annular passageway 30 formed by the reduced portion 29 of the valve stem 19 between the valve and the annular groove 27 in said stem and thus causes a minimum quantity of fuel to be discharged and thereby prevents a sudden pressure increase in the cylinder and consequent heavy running of the engine.

As soon as the outer end wall of the annular groove 27 clears the inner end of the flared valve seat 16, the full cross-sectional area of the annular chamber 28 is in communication with the annular discharge orifice 17*a* and the quantity of fuel delivered increases as the width of said annular discharge orifice is increased due to the outward movement of the flared head 26 of the valve and the flared hole 17 in the end wall 9 of the outer sleeve 5. When the pressure on the fluid fuel is released, the spring 20 operates to return the valve to closed position; and, during this return movement of the valve, the reduced portion 29 of the valve stem throttles or cuts down the quantity of fuel discharged and thus enables the valve to seat quickly at the end of the injection period so as to prevent after injection or nozzle dribble. The quantity of fuel delivered during the minimum injection and the length of time of such minimum injection are determined by the diameter and length, respectively, of the reduced portion 29 of the valve stem.

In the modification shown in Fig. 5, the outer end wall of the annular groove in the valve stem is beveled or radiused, as at 31, so as to prevent an abrupt change in the quantity of fuel delivered when said end wall clears the valve seat; and the head portion of the valve is tapered, as at 32, and terminates at its outer end in an outstanding flange 33 adapted to assist atomization of the fuel as it leaves the annular discharge or spraying orifice 17*b*.

What I claim is:

1. A fuel injector having a bore provided adjacent to its outer end with an outwardly opening valve seat, and an outwardly opening valve cooperating with said seat and having a cylindrical axial extension on its inner end slidably supported in said bore, said cylindrical extension having an annular groove therein cooperating with said bore to form a relatively wide annular chamber, said injector having a passageway leading to said annular chamber for supplying fuel thereto, the portion of said cylindrical extension between said valve and said annular groove being of less diameter than said bore and cooperating therewith to form a relatively narrow annular passageway that communicates with said relatively wide annular chamber and is adapted during the opening movement of said valve to throttle the fuel discharge until said annular groove enters said valve seat and places said relatively wide annular chamber in direct communication therewith.

2. A fuel injector having a bore formed adjacent to its outer end with an outwardly opening valve seat, and a spring retracted outwardly opening valve cooperating with said seat and having a stem on its inner end slidably supported in said bore, said stem having an annular groove therein cooperating with said bore to form an annular chamber, said injector having a passageway leading to said annular chamber for supplying fuel under pressure thereto, the portion of said stem between said valve and said annular groove being of less diameter than said bore but of greater diameter than said annular groove and cooperating with said bore to form an annular passageway that communicates with said annular chamber and is adapted during the early part of the opening movement of said valve to throttle the fuel discharge until the outer end wall of said annular groove enters said valve seat and places said relatively wide annular chamber in direct communication therewith.

3. A fuel injector having a bore provided inwardly of the outer end thereof with an outwardly opening valve seat therein, and an outwardly opening valve cooperating with said valve seat and having a stem on its inner end slidably supported in said bore and a head at its outer end disposed in the outer end of said bore and cooperating therewith to form an annular discharge orifice, said stem having an annular groove therein cooperating with said bore to form an annular chamber, said injector having a passageway for supplying fuel under pressure to said annular chamber, the portion of said stem between said valve and said annular groove being of less diameter than said bore but of greater diameter than said annular groove and cooperating with said bore to form an annular passageway between said annular chamber and said annular discharge orifice of smaller cross-sectional area than said annular chamber and adapted during the opening movement of said valve to throttle the fuel discharge until the outer end wall of said annular groove enters said valve seat.

4. A fuel injector having a bore having an outwardly opening valve seat therein adjacent to the outer end thereof, and a spring-loaded outwardly opening valve cooperating with said valve seat and having a stem on its inner end slidably supported in said bore and a head at its outer end disposed in the outer end of said bore and cooperating therewith to form an annular discharge orifice which increases in width during the outwardly opening movement of said valve, said stem having an annular groove therein having an inwardly sloping outer end wall and cooperating with said bore to form an annular chamber, said injector having a passageway for supplying fuel under pressure to said annular chamber, the portion of said stem between said valve and said annular groove being of less diameter than said bore but of greater diameter than said annular groove and cooperating with said bore to form an annular passageway between said annular chamber and said annular discharge orifice of smaller cross-sectional area than said annular chamber and adapted during the opening movement of said valve to throttle the discharge of fuel until said outer end wall of said annular groove enters said valve seat.

5. A fuel injector having a bore having a flared outwardly opening valve seat, and an outwardly opening valve cooperating with said seat and having an inwardly extending stem slidably supported in said bore and an outwardly extending tapering head portion that cooperates with the outer end of said bore to form an annular discharge orifice and terminates in an annular shoulder, and a spring for drawing said valve inwardly against said seat, said stem having an annular groove therein that cooperates with said bore to form an annular chamber, said injector having a passageway for supplying fuel under pressure to said annular chamber, the portion of said stem between said valve and said annular groove being of less diameter than said bore but of greater diameter than said annular groove and cooperating with said bore to form an annular passageway between said annular chamber and said annular discharge orifice of smaller cross-sectional area than said annular chamber and adapted during the opening movement of said valve to throttle the fuel discharge until the outer end wall of said annular groove enters said valve seat.

6. A fuel injector comprising a holder having a passageway therein, a removable nozzle comprising interfitting cylindrical inner, outer and intermediate sleeves, said inner sleeve having an outstanding flange at its outer end that overlaps the outer end of said intermediate sleeve and said outer sleeve having an outer end portion that overlaps said flange, a sleeve nut threaded on said holder and cooperating with said outer sleeve to clamp said intermediate sleeve against said holder and to clamp the flange at the outer end of said inner sleeve between the outer end of said intermediate sleeve and the outer end wall of said outer sleeve, said inner and intermediate sleeves having an annular passageway therebetween in communication with the passageway in said holder and the interior of said inner sleeve, and a valve for closing the outer end of said inner sleeve.

7. A fuel injector comprising a holder having a passageway therein, a removable nozzle comprising interfitting cylindrical inner, outer and intermediate sleeves, said inner sleeve having an outstanding flange at its outer end that overlaps the outer end of said intermediate sleeve and said outer sleeve having an outer end wall that overlaps said flange and has an axial hole therein, a sleeve nut threaded on said holder and cooperating with said outer sleeve to clamp said intermediate sleeve against said holder and to clamp the flange at the outer end of said inner sleeve between the outer end of said intermediate sleeve and the outer end wall of said outer sleeve, said inner and intermediate sleeves having an annular passageway therebetween in communication with the passageway in said holder and the interior of said inner sleeve, and a valve for closing the outer end of said inner sleeve, said valve having a head portion disposed in the axial hole in the outer end wall of said outer sleeve with an annular clearance space therebetween.

8. A fuel injector comprising a holder, having a passageway therein, a removable nozzle comprising interfitting cylindrical inner, outer and intermediate sleeves, said inner sleeve having an outstanding flange at its outer end that overlaps the outer end of said intermediate sleeve and said outer sleeve having an outer end wall that overlaps said flange and has an axial hole therein, a sleeve nut threaded on said holder and cooperating with said outer sleeve to clamp said intermediate sleeve against said holder and to clamp the flange at the outer end of said inner sleeve between the outer end of said intermediate sleeve and the outer end wall of said outer sleeve, said inner and intermediate sleeves having an annular passageway therebetween in communication with the passageway in said holder and the interior of said inner sleeve, and a valve for closing the outer end of said inner sleeve, said valve having a head portion disposed in the hole in the outer end wall of said outer sleeve with an annular clearance space therebetween, said valve having an inwardly extending stem portion slidably supported in said inner sleeve and adapted to cooperate therewith to form a restricted passageway therebetween during the early stage of the opening movement of said valve.

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