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2,503,458

FUEL INJECTION PUMP

Filed Feb. 11, 1946

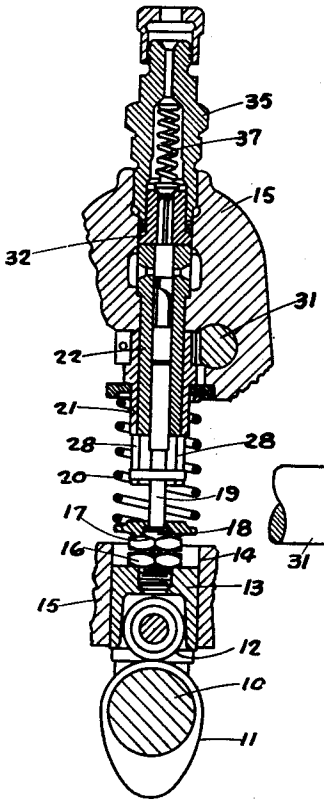


FIG. 1

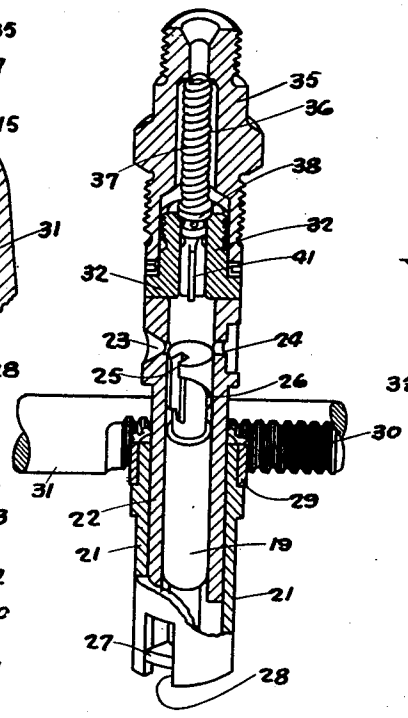


FIG. 2

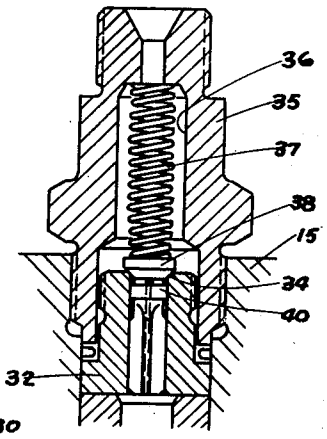


FIG. 3

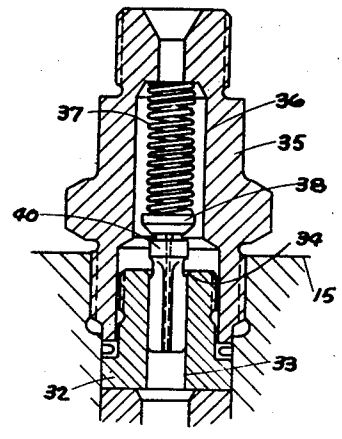


FIG. 4

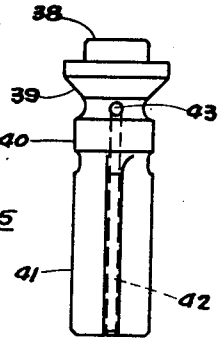


FIG. 5

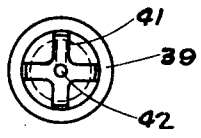


FIG. 6

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FUEL INJECTION PUMP

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7 Claims. (Cl. 103—228)

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This invention relates to internal combustion engines and is particularly directed to an improvement in the fuel injection system of the type commonly employed in connection with engines of the Diesel type.

Fuel injection pumps of a conventional design are customarily provided with means for varying or controlling the amount of fuel injected into each cylinder for each stroke of the piston. By this means the speed of the engine and the power available are normally controlled. I have found that this conventional control means for the fuel injection pump is not entirely satisfactory when the engine is being started initially. During the cranking operation for the purpose of starting the engine the control lever for the fuel injection mechanism must be set to deliver a larger quantity of fuel than normally would be injected during normal operation of the engine. When the fuel charge ignites during starting operations, the rotation of the crank shaft is accelerated very rapidly with the result that the engine operates at excessive speed for an interval of the time before the control mechanism can be readjusted to cut down the quantity of fuel delivered.

It is accordingly the principle object of my invention to provide an improved fuel injection mechanism which automatically will prevent racing of the engine immediately after starting.

Another object of this invention is to provide an improved fuel injection system which acts as an automatic governor when the engine is idling and thereby prevents undesirable fluctuations in idling speed.

Other objects and advantages will appear hereinafter.

In the drawings:

Fig. 1 is a sectional end elevational showing a conventional form of fuel injection valve, but which employs a fuel delivery valve embodying my invention.

Fig. 2 is a perspective sectional elevation on an enlarged scale showing details of the device shown in Fig. 1.

Fig. 3 is a sectional elevation of the portion of the device shown in Fig. 2 with the fuel delivery valve illustrated in "closed" position.

Fig. 4 is a view similar to Fig. 3 but with the fuel delivery valve illustrated in "open" or discharging position.

Fig. 5 is a side elevation of the fuel delivery valve.

Fig. 6 is a bottom end view of the valve shown in Fig. 5.

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Referring to the drawings, the fuel injection pump to which my invention is applicable may include a drive shaft 10 having a series of cam lobes 11 formed thereon, one for each individual pump. The cam lobes 11 each drive a follower roller 12, which is rotatably supported within a cross head 13. The cross head 13 is slidably mounted within a bore 14 in the housing 15. A fitting 16 threadedly connected to the cross head 13 carries a spherical seat 17 which is engaged by a spherical end 18 on the lower end of the plunger 19. A compression spring 20 encircles the plunger 19 and is adapted to maintain the spherical surfaces 17 and 18 in contact as well as to prevent separation of the cam 11 and the follower roller 12.

Mounted within the pump housing 15 for pivotal movement about the axis of the plunger 19 is a sleeve 21. Fixed to the housing and projecting downwardly within the sleeve 21 is a barrel 22 provided near its upper end with an inlet port 23 and an outlet port 24. The plunger 19 is ground and lapped to fit the bore of the barrel 22 and at its upper end the plunger is provided with an axially extending slot 25, one side of which is determined by a helical surface 26. The plunger 19 reciprocates within the barrel 22 with a constant length stroke determined by the shape of the cam 11. Means are provided for turning the plunger within the barrel 22 and, as shown, this means includes a laterally projecting foot 27 on the plunger which reciprocates in slots 28 formed on the lower end of the sleeve 21. The upper end of the sleeve 21 carries a gear segment 29 which meshes with rack teeth 30 formed on the reciprocable control bar 31. Longitudinal movement of the control bar 31 serves to rotate the sleeve 21 and hence turn the plunger 19 within the barrel 22 by means of the foot 27 and slot 28.

Fixed to the upper end of the barrel 22 and in coaxial relation therewith is a delivery valve fitting 32 having a central cylindrical bore 33 terminating at its upper end in a valve seat 34. The delivery valve fitting 32 is maintained in place by an enclosure fitting 35 which is threaded within the housing 15. The enclosure fitting 35 has a central chamber 36 enclosing a coil spring 37 which acts against the upper face of a fuel delivery valve 38. The fuel delivery valve 38 has a conical sealing surface 39 adapted to seat on the valve seat 34. Axially spaced from the conical sealing surface 39 is a cylindrical piston 40 which fits within the bore 33 in slidable relation. A plurality of guide vanes or flutes 41 is provided on the lower end of the delivery valve 38. These flutes

extend radially outwardly and are shaped to fit in sliding contact with the cylindrical bore 33.

The mechanism described so far is conventional in character and operates in the following manner:

Rotation of the cam 11 causes reciprocation of the cross head 13 and plunger 19. When the upper end of the plunger passes the position shown in Fig. 2 and moves upwardly past the inlet port 23, a quantity of fuel is trapped within the upper end of the barrel 22 above the plunger 19. Upward movement of the plunger raises the pressure of the fluid so trapped and this pressure acts on the fuel delivery valve 38 to move it in an upward direction in opposition to the compression spring 37. When the piston 40 moves out of the bore 33 fuel may pass upwardly between the flutes 41 and past the valve seat 34 into the chamber 36. A discharge line (not shown) is connected to the upper end of the fitting 35 for conveying injected fuel to the engine cylinder by way of the customary nozzle valve in the other end of the discharge tubing. Upward movement of the plunger 19 causes discharge of fuel past the fuel delivery valve 38 in proportion to movement of the plunger 19 until the helix surface 26 registers with the outlet port 24. At the instance of registry the pressure of the fuel within the bore 33 and within the barrel above the plunger is vented through the slot 25 and the space below the helix 26 to the outlet port 24. The resulting drop in pressure within the bore 33 causes the coil spring 37 to move the fuel delivery valve 38 quickly to closed position. At the time of closing, the piston 40 reenters the bore 33 and hence reduces the pressure within the chamber 36 and discharge tubing (not shown) by an amount proportional to the volume of the piston 40. This pressure reduction in the discharge tubing immediately following injection of fuel is beneficial since it permits the nozzle valve at the other end of the discharge tubing to snap shut on its seat, thus instantaneously terminating the injection of fuel.

The fuel delivery valve 38 does not reopen until the plunger 19 is again raised during the regular stroke of the pump. Variations in quantity of fuel delivered are effected by turning the plunger 19 in the manner described above. Turning of the plunger 19 within the barrel serves to change the point at which the helix 26 registers with the outlet port 24 during the stroke of the plunger 19. It, therefore, will be understood that while the plunger stroke does not vary, the quantity of fuel delivered per stroke can be changed at will by turning the plunger 19 within the barrel 22 by means of the control bar 31.

The improvement to which this invention is directed comprises the provision of a by-pass or supplementary passage in the fuel delivery valve 38 which communicates with the bore 33 above and below the piston 40. As shown in the drawings, this by-pass includes an axial hole 42 drilled centrally from the lower end of the valve along the axis thereof to a position adjacent the sealing surface 39. A lateral port 43 is then drilled into the central hole 42. The size of the hole 42 and the port 43 is important since it controls the amount of fuel which will pass through it when the valve surface 39 is unseated. From actual performance data I have found that the addition of this supplementary passage 42, 43 materially facilitates easy starting of the engine. Under the relatively slow cranking speed, the delivery valve 38 reciprocates in the bore 33

at a correspondingly slow speed since the cam shaft 10 of the fuel injection pump is driven in timed relation with the engine crank shaft. During this relatively slow movement, the supplementary passage 42, 43 acts to deliver an increased quantity of fuel for each stroke of the engine piston. When the fuel charge ignites and the engine begins to run on its own power, the engine crank shaft is accelerated very rapidly, so that only a few revolutions are required to bring the engine crank shaft up to operating speed. The rapid increase in speed of the engine crank shaft is reflected in a rapid increase in rate of reciprocation of the plunger 19 and hence of the delivery valve 38. Under normal speed or high speed operation, the effect of the supplementary passage 42, 43 becomes negligible since the time required to pass any appreciable fluid through the passage 42, 43 becomes shorter and shorter as the speed of the engine increases.

The supplementary passage 42, 43 has an additional beneficial effect on the engine operation since it acts as an automatic governor to insure injection of adequate quantities of fuel to maintain the idling speed of the engine sufficiently high for reliable operation without possibility of stopping. Thus, when the engine speed tends to fall below a safe value, the effect of the supplementary passage 42, 43 is to supply additional quantities of fuel and hence, increase the engine speed to the minimum permissible value for safe idling. Should the engine speed exceed the desired idling speed, the effect of the supplementary passage 42, 43 decreases with increasing speed with the result that decreased quantities of fuel are injected and hence the engine speed falls off. Under normal operation of the engine at medium speed and high speed, the effect of the supplementary passage 42, 43 is negligible.

Having fully described my invention, it is to be understood that I do not wish to be limited to the details herein set forth, but my invention is of the full scope of the appended claims.

I claim:

1. In a fuel injection pump for an internal combustion engine, the combination of a barrel having a reciprocable plunger therein, inlet and outlet ports communicating with said barrel, a bore adjacent said barrel having a valve seat at the outer end thereof, a fuel delivery valve slidably mounted within said bore and having a sealing surface adapted to engage said valve seat, an annular piston on said valve axially spaced from said sealing surface and adapted to form a sliding fit within said bore, the valve having primary passage means whereby fluid in said bore may pass through the valve seat upon movement of the piston out of the bore, and secondary passage means in said valve terminating in a lateral port positioned between said piston and said sealing surface and communicating with the interior of said bore.

2. In a fuel injection pump for an internal combustion engine, the combination of a barrel having a reciprocable plunger therein, inlet and outlet ports communicating with said barrel, a cylindrical bore adjacent said barrel having a conical valve seat at the outer end thereof, a fuel delivery valve having guide vanes slidably mounted within said bore and having a conical sealing surface adapted to engage the valve seat, an annular piston on said valve axially spaced from said conical sealing surface and adapted to form a sliding fit within said cylindrical bore,

the guide vanes defining primary passage means whereby fluid in said bore may pass through the valve seat upon movement of the piston out of the bore, secondary passage means in said valve including an axial passageway extending from the end of the valve having the guide vanes to a point adjacent the conical sealing surface, and a lateral port between the annular piston and the conical sealing surface communicating with the axial passageway.

3. A delivery valve for a fuel injection pump having in combination a conical sealing surface near the upper end thereof, an annular piston axially spaced from said conical sealing surface defining a cylindrical surface, a plurality of guide vanes extending radially outwardly and having their outer edges shaped to conform substantially to said cylindrical surface, the guide vanes defining primary passage means therebetween terminating at said piston, and secondary passage means in said valve including an axial passageway extending from the lower end of the valve to a point above the position of said annular piston, and a lateral port between the annular piston and the conical sealing surface communicating with the axial passageway.

4. A delivery valve for a fuel injection pump having in combination a sealing surface near the upper end thereof, an annular piston axially spaced below said sealing surface defining a cylindrical surface, a plurality of guide vanes below said piston extending radially outwardly and having their outer edges shaped to conform substantially to said cylindrical surface, the guide vanes defining primary passage means therebetween terminating at said piston, and secondary passage means in said valve extending from a point below said annular piston to a lateral outlet port between the annular piston and the sealing surface.

5. In a fuel injection pump for an internal combustion engine, the combination of a cylindrical bore having a valve seat at the upper end thereof, a fuel delivery valve having guide vanes extending radially outwardly into sliding contact with said cylindrical bore, the guide vanes defining fuel delivery passage means therebetween, a conical sealing surface on said valve axially spaced above said guide vanes and adapted to engage said valve seat, an annular piston on said valve positioned intermediate the guide vanes and the conical sealing surface and adapted to form a sliding fit within said cylindrical bore,

and fuel bypass means in said valve including a passageway communicating with the interior of said cylindrical bore at spaced points above and below said annular piston.

6. In a fuel injection pump for an internal combustion engine, the combination of a cylindrical bore having a valve seat at the upper end thereof, a fuel delivery valve having guide vanes extending radially outwardly into sliding contact with said cylindrical bore, the guide vanes defining fuel delivery passage means therebetween, a conical sealing surface on said valve axially spaced above said guide vanes and adapted to engage said valve seat, an annular piston on said valve positioned intermediate the guide vanes and the conical sealing surface and adapted to form a sliding fit within said cylindrical bore, and fuel bypass means in said valve including an axial passageway extending from the lower end of the valve to a point above the position of said annular piston, and a lateral port between the annular piston and the conical sealing surface communicating with the axial passageway.

7. In a fuel injection pump for an internal combustion engine, the combination of a member provided with a cylindrical bore, said member having a valve seat at one end of the bore, a fuel delivery valve slidably mounted within said bore and provided with a valve head adapted to close against said valve seat, the valve having a cylindrical portion adapted to form a sliding seal within said bore, means on the valve forming a relatively large primary passage means whereby fluid in said bore may pass through the valve seat upon movement of said cylindrical portion out of the bore, and a relatively small secondary passage means in said valve terminating in a lateral port positioned between said valve head and said cylindrical portion and communicating with the interior of said bore.

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