

Fuel injection pump

This invention relates to fuel injection pumps.

The efficiencies of prior fuel injection pumps have been limited due to the tendency of such pumps to excessively aerate fuel and to insufficiently cool fuel before delivery to an associated injection nozzle. Since fuel density is inversely related to the degree of aeration and fuel temperature, the weight of fuel delivered with each stroke of a constant volume pump is necessarily relatively low when fuel temperature is high or when the fuel is excessively aerated, with a corresponding decrease in pump efficiency. Uncontrollable aeration and fuel temperature result in uncontrollable fuel delivery rates and efficiency.

Fuel is supplied to prior fuel pumps through a single- or double-ported barrel communicating with either individual fuel lines or a manifold intermediate the pump and a fuel tank. A plunger received in the barrel has a recessed scroll surface on an end, or intermediate its ends, for receipt of fuel from at least one port. Fuel is expelled from the scroll to a nozzle during an injection stroke, with excess fuel being spilled to a return line through an outlet port.

CH—A—227851 sets out to overcome the problem of fuel aeration, disclosing a pump having a radial outlet port, and an inlet port extending between a peripheral recess and the central bore, the inlet and outlet ports being on opposite sides of the bore at the same point along its length. Fuel is passed from the recess to the bore through the inlet port and via the outlet port directly to an outlet conduit. With such a pump there can be no problems with the phasing of fuel input and output, due to the equal height of the two ports.

US—A—1,989,720, shows a more complex design of pump in which fuel spillage is achieved through a series of connected passages, but in which there is a common chamber from which fuel is drawn and to which it is spilled.

According to the present invention, a fuel injection pump having an annular fuel receiving cavity formed by a peripheral recess is characterized by a fuel supply and deaeration chamber in the housing spaced from one side of the pump barrel generally opposite the inlet port; and a pair of fuel conduits in the housing, one of the fuel conduits being linearly aligned with and adjacent to the outlet port and the other of the conduits communicating with the annular cavity without alignment with either of the ports, and both conduits extending between the fuel chamber and the annular cavity, while both of the inlet and outlet ports extend from the annular cavity to the bore, and the inlet port is displaced axially of the plunger relative to the outlet port whereby the outlet port can be blocked by the plunger during filling of the fuel

injection chamber through the inlet port and the inlet port can be blocked by the plunger during spilling of fuel from the chamber through the outlet port at the end of injection.

One example of a fuel pump according to the invention will be described with reference to the accompanying drawings in which:—

Figure 1 is a vertical sectional view of a fuel pump; and

Figure 2 is a horizontal sectional view taken along line 2—2 of Figure 1.

Referring to Fig. 1, a fuel injection nozzle 10 is supplied with fuel via a supply line 12 from a fuel pump, generally designated 14, disposed in a housing 16. The housing 16 defines a cavity 18 which receives a pump barrel 22. A bore 23 in the pump barrel 22 reciprocally and rotatably receives a plunger 24 which in turn mounts an annular retainer 26 carried by a lifter 28. A helical spring 30 is disposed between the retainer 26 and a shoulder on the exterior of the pump barrel 22, and biases the lifter 28 toward the surface of a rotating cam 34.

A rack 36 engages a pinion 38 on the plunger 24 to maintain the plunger 24 in a predetermined position of relative rotation, as described below. Conventionally, a single pump assembly is provided for each cylinder of a multi-cylinder engine; Fig. 2 illustrates a second pump barrel 40 adjacent the pump barrel 22.

A fuel reservoir or gallery 50 is formed in and extends laterally of the housing 16. The fuel reservoir 50 receives pressurized fuel from a main supply source through a fitting 52 at a pressure of between about 25 and 50 psi (172 and 345 KPa) at which the fuel is maintained while within the reservoir 50. A return line with a combination orifice, bypass valve and manual bleed valve (none shown) extends from the reservoir 50 to the main fuel supply to allow air and excess fuel to be removed from the reservoir without loss of pressure from the reservoir 50.

The pump barrel 22 is retained in the housing 16 between a stationary fuel outlet conduit 53 and an annular stop 54.

An annular recess 56 about the outer periphery of the pump barrel 22 cooperates with the wall of the housing 16 to form an annular cavity 58 about the pump barrel 22. First and second radial bores define a spill port 60 and a fill port 62 in the pump barrel 22 and place the central bore 23 and the annular cavity 58 in communication. The port 60 is aligned with a fuel outlet conduit 64 to place the bore 23 in communication with the fuel reservoir 50. The annular cavity 58 communicates with the reservoir 50 through a fuel inlet conduit 66 in the housing 16.

Preferably, the port 62 is disposed radially from the port 60 at an angle of 180° and is spaced axially from the port 60 toward the

outlet end 70 of the bore 23. The outlet end 70 of the bore 23 communicates with the line 12 via a conventional scratched check valve 72 which seats against the pump barrel 22 and which is yieldably urged thereagainst by a spring 74 between the valve 72 and the conduit 53.

The plunger 24 includes at its uppermost end 80 a scroll defined by a groove 82 of a diameter less than that of the bore 23 extending about the circumference of the plunger 24. The groove 82 has a varying axial length on the plunger 24, as shown by the dotted line. The plunger 24 may set in a predetermined angular position within the bore 23 by rotation of the pinion 38 by the rack 36 in a conventional manner, whereby a portion of the scroll groove 82 of desired axial length may be placed in registration with the port 60.

In operation, reciprocating movement of the plunger 24 is effected by rotation of the cam 34, with upward movement of the plunger 24 comprising an injection stroke and downward movement of the plunger 24 comprising a fill stroke, wherein a pump chamber 89 defined by the scroll groove 82 and the upper portion 92 of the barrel bore 23 is filled with fuel for the next injection stroke. In Fig. 1, the plunger 24 is shown midway through its injection stroke.

In the configuration of Fig. 1, the chamber 89 is filled with fuel under maximum pressure due to blocking of the ports 60 and 62, and the fuel can exit the chamber 89 only by flow through the check valve 72, the conduit 53 and the line 12. As the plunger continues its upward stroke, the scroll groove 82 aligns with the port 60, resulting in flow of fuel through the port 60 in the direction of the arrows in Figs. 1 and 2 due to the relatively great pressure drop between the chamber 92 and the reservoir 50, whereupon fuel pressure in the line 12 urges the check valve 72 to seat against the pump barrel 22. Fuel remaining in the barrel flows to the reservoir 50 through the port 60 and the conduit 64.

After reaching its apex, the plunger 24 begins its downward stroke and, after opening of the port 62, draws fuel from the reservoir 50 through the conduit 66 and the port 62 to the upper portion 92 of the bore; the scroll groove 82 and the chamber 89. Flow from the reservoir 50 through the conduit 64 and the port 60 during a part of the downward stroke is minimal due to inertia of high pressure fuel remaining therein from the preceding upward plunger stroke.

Relatively cool fuel flowing from the reservoir 50 to the port 62 follows a relatively lengthy route through the conduit 66 and the annular cavity 58, resulting in further cooling and consequent densification, allowing the plunger stroke to convey a relatively great weight of fuel to the pump nozzle 10, thereby enhancing pump efficiency. Air escaping from fuel in the reservoir 50 returns to the fuel supply

source through a valve 93 leading to a return line (not shown).

Excess fuel discharged through the spill port 60 and the conduit 64 is under a relatively high pressure and at a correspondingly high velocity. A baffle 93 of hardened metal is secured to an upstanding projection 94 in the reservoir 50, as by a bolt 96. The baffle 93 deflects high pressure, high velocity fuel into the main chamber of the reservoir 50, and prevents erosion of the housing's surfaces. The fuel exiting the conduit 64 is at a high temperature, and is cooled by mixing with relatively cool fuel in the relatively large volume of the reservoir 50, thereby displacing relatively hot fuel through the valve 93. Any air entrained in the fuel is dispersed due to the sudden decompression of the fuel. Dispersion of entrained air is aided by the relatively long residence time of the fuel in the reservoir.

Fuel flow through any of the ports 60 and 62 or the conduits 64 and 66 is in one direction only, except for minimal flow through the conduit 64 and the port 60 during the downward fill stroke of the plunger. This predominantly one-way flow allows cooling of fuel and minimizes fuel aeration which, in turn, enhances fuel density and, therefore, pump efficiency.

The relatively large volume of the reservoir 50 and, to a lesser extent, that of the cavity 58 relative to the volume of the injection chamber 89 effectively maintains the fuel temperature and entrained air content at a uniformly low level, thereby minimizing fluctuations in fuel density, resulting in the delivery of a consistent amount of fuel to the injection nozzle 10 on each stroke.

It has been found that the embodiment described herein may increase the volumetric efficiency of the pump from about 65% to 95%.

Claims

1. A fuel injection pump (14) comprising a pump barrel (22) having a central bore (23) an outer peripheral recess (56), and inlet and outlet ports (62, 60), circumferentially spaced and substantially oppositely directed; a housing (16) receiving the pump barrel (22) and cooperating with the peripheral recess (56) to define an annular fuel receiving cavity (58) about the barrel (22); a plunger (24) received by the pump barrel bore (23) and having a surface at one end (80) for selective registration with the ports (60, 62), the plunger (24) cooperating with the pump barrel (22) and housing (16) to form a fuel injection chamber (92); characterized by a fuel supply and deaeration chamber (50) in the housing (16) spaced from one side of the pump barrel (22) generally opposite the inlet port (62); and a pair of fuel conduits (64, 66) in the housing, one of the fuel conduits (64) being linearly aligned with and adjacent to the outlet port (60) and the other of the conduits (66) com-

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municating with the annular cavity (58) without alignment with either of the ports (60, 62), and both conduits (64, 66) extending between the fuel chamber (50) and the annular cavity (58), while both of the inlet and outlet ports (62, 60) extend from the annular cavity to the bore (23), and the inlet port (62) is displaced axially of the plunger (24) relative to the outlet port (60) whereby the outlet port (60) can be blocked by the plunger (24) during filling of the fuel injection chamber (92) through the inlet port (62) and the inlet port (62) can be blocked by the plunger (24) during spilling of fuel from the chamber (92) through the outlet port (60) at the end of injection.

2. A fuel pump according to claim 1 wherein the fuel chamber (50) has a baffle (93) disposed therein in alignment with the fuel conduit (64) for deflection of fuel received therefrom.

Revendications

1. Pompe d'injection de combustible (14) comprenant un barillet de pompe (22) ayant un alésage central (23), une cavité périphérique extérieure (56), et des orifices d'entrée et de sortie (62, 60), espacés circonférentiellement et dirigés pratiquement à l'opposé; une enveloppe (6) recevant le barillet de pompe (22) et coopérant avec la cavité périphérique (56) pour délimiter une cavité annulaire de réception de combustible (58) autour du barillet (22); un plongeur (24) reçu par l'alésage (23) du barillet de pompe et ayant une surface à une extrémité (80) pour coïncider sélectivement avec les orifices (60, 62), le plongeur (24) coopérant avec le barillet de pompe (22) et l'enveloppe (16) pour former une chambre d'injection de combustible (92); caractérisé par une chambre d'alimentation de combustible et de désaération (50) dans l'enveloppe (16) espacée d'un côté du barillet (22) généralement opposé à l'orifice d'entrée (62); et par deux conduits de combustible (64, 66) dans l'enveloppe, l'un des conduits de combustible (64) étant linéairement aligné avec et voisin de l'orifice de sortie (60), tandis que l'autre conduit (66) communique avec la cavité annulaire (58) sans être aligné avec l'un ou l'autre des orifices (60, 62), les deux conduits (64, 66) s'étendant entre la chambre à combustible (50) et la cavité annulaire (58), tandis que les orifices d'entrée et de sortie (62, 60) s'étendent tous deux de la cavité annulaire à l'alésage (23), et que l'orifice d'entrée (62) est déplacé axialement du plongeur (24) par rapport à l'orifice de sortie (60), ce qui fait que l'orifice de sortie (60) peut être bloqué par le plongeur (24) pendant le remplissage de la chambre d'injection (92) par l'orifice d'entrée (62), et que l'orifice d'entrée (62) peut être bloqué par le plongeur (24) pendant l'effusion du combustible de la chambre (92) par l'orifice de sortie (60) à la fin

de l'injection.

2. Pompe à combustible selon la revendication 1, dans laquelle la chambre à combustible (50) renferme un écran (93) aligné avec le conduit de combustible (64) afin de dévier le combustible reçu de celui-ci.

Patentansprüche

1. Brennstoffeinspritzpumpe (14), die folgendes aufweist: eine Pumpentrommel (22) mit einer Mittelbohrung (23), einer Außenumfangsausnehmung (56) und Einlaß- und Auslaßöffnungen (62, 60), umfangsmäßig mit Abstand und im wesentlichen entgegengesetzt gerichtet angeordnet, ein Gehäuse (16) zur Aufnahme der Pumpentrommel (22) und zusammenarbeitend mit der Umfangsausnehmung (56) zur Definition eines ringförmigen Brennstoffaufnahmehohlraums (58) um die Trommel (22) herum, einen Kolben (24), aufgenommen durch die Pumpentrommelbohrung (23) und mit einer Oberfläche an einem Ende (80) zur selektiven Ausrichtung mit den Öffnungen (60, 62), wobei der Kolben (24) mit der Pumpentrommel (22) und dem Gehäuse (16) zusammenarbeitet, um eine Brennstoffeinspritzkammer (92) zu bilden, gekennzeichnet durch eine Brennstoffversorgungs- und Entlüftungskammer (50) in dem Gehäuse (16), mit Abstand angeordnet von einer Seite der Pumpentrommel (22) im allgemeinen entgegengesetzt zur Einlaßöffnung (62), und gekennzeichnet durch ein Paar von Brennstoffleitungen (64, 66) im Gehäuse, wobei die eine der Brennstoffleitungen (64) linear ausgerichtet ist mit und benachbart angeordnet ist zu der Auslaßöffnung (60) und wobei die andere der Leitungen (66) in Verbindung steht mit dem Ringhohlraum (58) ohne Ausrichtung mit einer der Öffnungen (60, 62), und wobei ferner die beiden Leitungen (64, 66) sich zwischen der Brennstoffkammer (50) und dem Ringhohlraum (58) erstrecken, während sowohl die Einlaß- als auch Auslaßöffnungen (62, 60) sich von dem Ringhohlraum zur Bohrung (23) erstrecken, und wobei die Einlaßöffnung (62) axial zum Kolben (24) bezüglich der Auslaßöffnung (60) versetzt ist, wodurch die Auslaßöffnung (60) durch den Kolben (24) während des Füllens der Brennstoffeinspritzkammer (92) durch die Einlaßöffnung (62) blockiert werden kann, und wobei die Einlaßöffnung (62) durch den Kolben (24) während des Überlaufens von Brennstoff aus der Kammer (92) durch die Auslaßöffnung (60) am Ende der Einspritzung blockiert werden kann.

2. Brennstoffpumpe nach Anspruch 1, wobei die Brennstoffkammer (50) eine darin in Ausrichtung mit der Brennstoffleitung (64) angeordnete Prallplatte (93) zur Ableitung des von dort aufgenommenen Brennstoffs angeordnet ist.