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3,126,158

FUEL INJECTION NOZZLE

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2 Sheets-Sheet 1

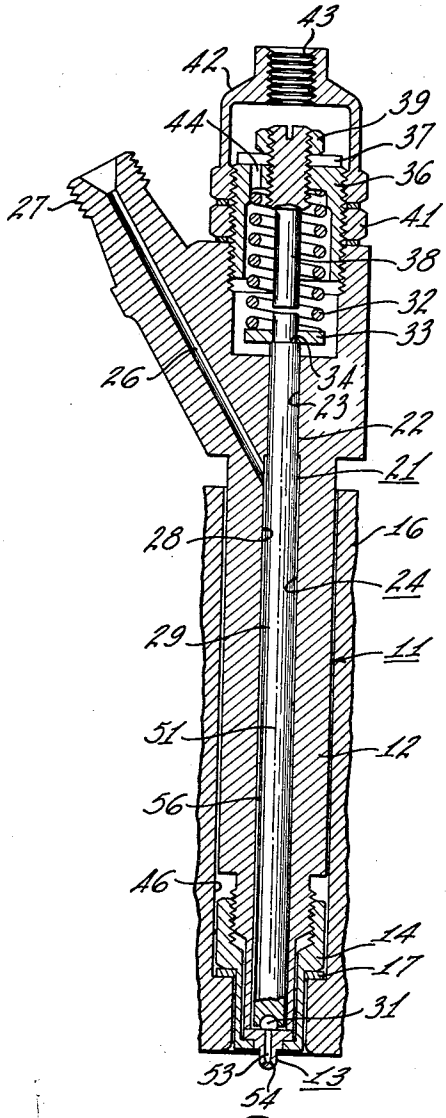


Fig. 1

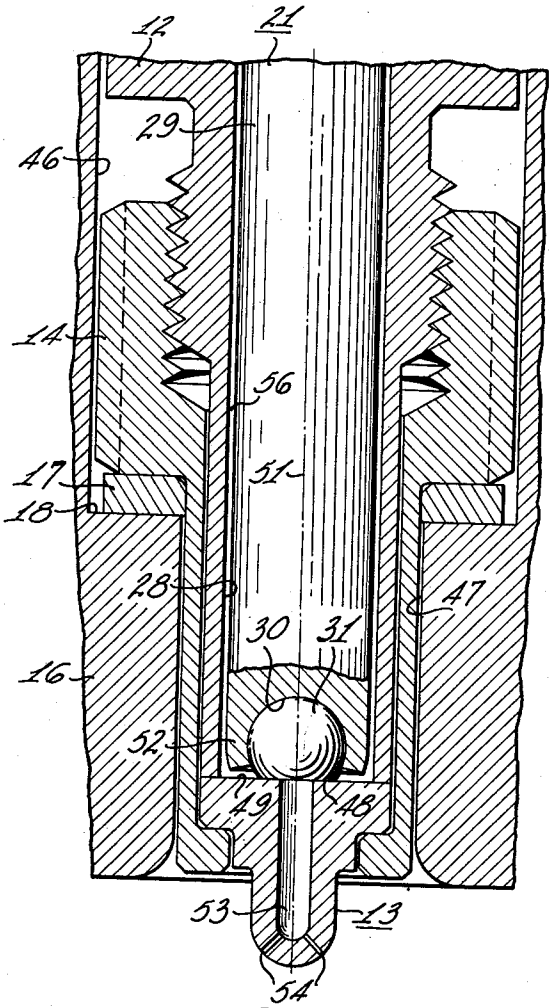


Fig. 2

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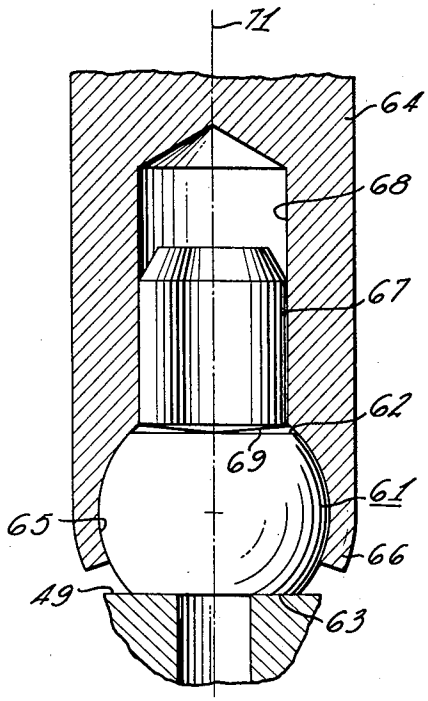


Fig. 3

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3,126,158

FUEL INJECTION NOZZLE

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This invention relates to a fuel injection nozzle for internal combustion engines, and particularly to a valve for an injection nozzle of the type actuated by the pressure of the fuel being injected into the engine.

Heretofore various types of fuel injecting nozzles have been suggested for compression ignition engines, however, improvements in such nozzles have been sought to reduce cost and eliminate certain problems regarding use and operation of such prior art nozzles. In certain fuel pressure operated injection nozzles heretofore suggested, it has been necessary to provide a deep drilled fuel passage which increased the diameter of the nozzle holder thereby taking up valuable space that would otherwise be available for cooling passages, air and exhaust passages, and intake and exhaust valves. In fuel injectors of the prior art utilizing a deep drilled fuel passage, the lapped cylindrical surfaces forming a fluid seal between the movable valve and the stationary nozzle holder were near the nozzle orifices and consequently near the point of highest engine temperature, that is the combustion chamber. Sealing surfaces near the nozzle tend to warp due to the high temperature of the combustion chamber and fuel leakoff increases upon warping. In nozzles previously suggested, extremely close concentricity tolerances of the reciprocal valve element and nozzle body were necessary for proper function of the nozzle. Provision of such tolerances results in expensive nozzles.

It is an object of this invention to provide a fluid pressure actuated injection nozzle assembly which eliminates the requirement for drilling a separate fuel supply passage longitudinally through the nozzle holder.

It is a further object of this invention to provide a fluid pressure operated nozzle valve which permits the use of a nozzle holder of relatively small diameter.

It is a further object of this invention to provide a fluid pressure operated nozzle valve which eliminates the necessity of extremely close concentricity tolerances between the valve, holder and nozzle.

It is a further object of this invention to provide a self-aligning nozzle valve, for a fuel injection nozzle.

It is a further object of this invention to provide a fuel injection nozzle assembly with self-aligning nozzle valve wherein the cylindrical sealing surfaces between the reciprocating portion of the valve and the holder are remote from the high temperature area of the fuel emitting orifices of the nozzle.

It is a further object of this invention to provide a fuel injection nozzle assembly which has a relatively low manufacturing cost.

These and other objects of this invention will be apparent to those familiar with the art when the following description is read in conjunction with the drawings in which:

FIG. 1 is a section view of an injection nozzle assembly utilizing this invention;

FIG. 2 is an enlarged view of the nozzle and valve portions of the nozzle assembly shown in FIG. 1; and

FIG. 3 is a section view of a second embodiment of this invention.

Referring to FIGS. 1 and 2, the nozzle assembly 11 incorporating my invention includes a nozzle holder 12 and a nozzle 13 held together by a nozzle nut 14. The nozzle assembly is shown installed in a cylinder head 16 of an internal combustion engine of the compression

ignition type. The nozzle assembly is held in place by conventional means, not shown, and a nozzle gasket 17 is interposed between the nozzle nut 14 and a ledge 18 in the cylinder head. A nozzle valve 21 has a lapped cylindrical surface 22 in fluid sealing engagement with complementary lapped cylindrical surface 23 formed in the upper end of the bore 24 in the nozzle holder 12.

An angularly drilled passage 26 extends between a connection 27, adapted to receive a pressure fuel line from an injection pump, not shown, and an enlarged bore portion 28 extending between surface 23 and the bottom of the holder. Fuel under pressure is delivered to passage 26 in the holder and thence passes around the spindle 29 of the valve 21 to the bottom of the assembly where a truncated ball 31 is held against nozzle 13. The truncated ball 31 mounted in socket 30 is held in a closed position by a coil spring 32 interposed between the spring seat 33 carried on a shoulder 34 of the valve spindle 29 and a spring retainer 36. The spring retainer is threaded into a complementary threaded cavity at the upper end of the nozzle holder and has a slot 37 for receiving a screwdriver blade. A lift screw 38 has a threaded engagement with the spring retainer 36 and is locked in adjusted position by lock nut 39. A lock nut 41 is provided for securing the retainer 36 in a desired position in the holder 12. Cap 42 is in threaded engagement with the spring retainer 36 and has a leakoff connection 43 at its upper end for connection with a fuel return line, not shown. A hole 44 is provided in the spring retainer to permit any fuel leaking past the fluid sealing surfaces 22, 23 to return to the input side of the injection pump, not shown.

Referring to FIG. 2, the nozzle nut 14 is in conventional threaded engagement with the nozzle holder 12 and the holder and nut are of smaller diameter than the injector hole 46 provided in the cylinder head. The nozzle nut 14 is of a stepped design having its lower end extending into a reduced diameter portion 47, of the injector hole 46. The nozzle 13 is held in fluid tight engagement with the bottom surface of the nozzle holder 12 by the nozzle nut 14. The truncated ball 31 is manufactured by forming a flat surface 48 on a solid sphere. The flat sealing surface 48 is in complementary fluid sealing relation to a flat sealing surface 49 formed on the nozzle 13 at right angles to the axis 51 of the cylindrical surfaces 22, 23. The truncated surface 48 has a diameter which is smaller than the diameter of the ball 31 and is smaller than the diameter of cylindrical sealing surface 22 on spindle 21. The truncated ball 31 is swivelly held in socket 30 at the end 52 of the spindle 29 by crimping the end 52 about the ball thereby forming a ball and socket joint preventing axial separation of these two parts. The nozzle 13 is provided with a passage 53 which is shown closed off by the flat surface 48 of the truncated ball 31.

Prior to valve 21 raising, fuel pressure acts downward on the area of surface 48 and upward on the cross sectional area of the spindle at its cylindrical sealing surface 22 forming a resultant force tending to raise the valve against the force of spring 32. At a predetermined fuel pressure the valve begins to lift and injection through orifices 54 commences. After opening, fuel pressure acts upward on an area equal to the cross sectional area of the spindle at its cylindrical sealing surface 22, resulting in a force which snaps the valve to a full open position. When the pressure in the fuel supply line drops, the valve will close in a reverse sequence assuring positive seal and no dribble. Valve 21 opening pressure is regulated by adjustment of spring retainer 36. The nozzle valve lift is regulated by the adjustment of lift screw 38 which is in abutting relation to the top valve 21. Upon relapping

surface 48, the lift screw 38 may be adjusted to provide the correct lift.

In some installations the truncated ball is rotated somewhat during opening by the action of the pressurized fuel entering between the sealing surfaces 48, 49. Such rotation places the sealing surface 48 in angular relation to sealing surface 49 and during closing edge or line contact is made with surface 49 which results in scuffing as the surfaces 48, 49 complete their fluid sealing engagement.

FIG. 3 illustrates means for preventing excessive rotation of the ball. The truncated ball 61 is flattened symmetrically on opposite sides to prevent upper and lower flat parallel surfaces 62, 63. The bottom surface 63 is a fluid sealing surface adapted to have fluid sealing engagement with the flat fluid sealing surface 49 on the nozzle. The truncated ball 61 is seated in spherical socket 65 and is secured to spindle 64 for axial movement therewith by the bottom end 66 being crimped about the spherically formed surface of the ball 61.

Rotation restraining means in the form of a dowel 67 is press fitted into a suitable axial bore 68 in the end of the spindle 64. The dowel 67 has a conical surface 69 at its lower end in abutting relation to flat surface 62 of ball 61. This rounded abutment surface 69 is symmetrical about the axis 71 of the spindle 64 which is also the axis of dowel 67 and passes through the center of ball 61. The rounded abutment surface 69 defines a cone whose angle is a few less than 180 degrees. Thus with the tip of the cone shaped surface 69 contacting the flat surface 62 it can be appreciated that the dowel acts as a motion restraining element permitting only slight rotation of the truncated ball 61 in a direction to cause tipping of sealing surface 63. Thus the rotation restraining means for the ball maintains sealing surface 63 in approximate right angle relationship to the axis 71 of the spindle 64, thereby preventing scuffing type wear of the sealing surface on which the ball seats. Since the sealing surface 49 on the nozzle is at right angles to the axis of the spindle, the motion restraining element maintains flat sealing surface 63 substantially parallel to the sealing surface 49.

This fuel injection nozzle assembly is low in manufacturing cost due to elimination of the extremely close concentricity and squareness tolerances heretofore required. The nozzle design of this invention does not require a plurality of concentric cylindrical surfaces to be formed on a single part with extremely close tolerances. By swivelly mounting the truncated ball 31 in the socket 30 of spindle 29, the flat sealing surfaces 48, 63, 49 need only be lapped to a suitably flat condition whereby their mating contact, under the biasing of spring 32, will prevent passage of fuel, through cavity 56 between the spindle 29 and the holder 12, to nozzle passage 53.

Heretofore in flat seated nozzle valves, it was necessary that the nozzle seat be absolutely perpendicular to the axis of the valve. No such exacting manufacturing requirement is needed to manufacture the nozzle assembly of this invention. Also, the deep hole formerly drilled longitudinally in the nozzle holder, in generally parallel relation to the reciprocating valve of the nozzle assembly, is not required in my design.

My nozzle assembly also has an advantage in its being inexpensively serviced. When the nozzle requires replacement, it may be removed and replaced and since the sealing surface of the truncated ball is a simple flat surface, it can easily be renewed by lapping it to a flat surface.

By placing the lapped surfaces 22, 23 near the upper end of the nozzle holder, I permit the fuel supply cavity 56 to be formed between the spindle 29 and the enlarged portion 28 of bore 24 and I have also placed these lapped fluid sealing surfaces 22, 23 in a position remote from the nozzle 13. This results in another advantage in that the sealing surfaces 22, 23 are removed from the point of highest temperature, that is the nozzle vicinity.

Thus the precision surfaces 22, 23 are not in danger of being warped due to excessive temperatures.

As is obvious, from the drawings, the nozzle assembly of this invention fits into a small diameter hole in the head of the engine. The nozzle holder diameter is permitted to be a minimum by virtue of elimination of a separate longitudinal drilled passage in the holder beside the bore provided for the spindle. By providing a small diameter nozzle assembly additional space is available in the head of the engine for cooling passages, air inlet or exhaust passages and inlet and exhaust valves.

Although only two variations of this invention have been disclosed herein it is not intended to limit this invention except as necessitated by the scope of the appended claims.

This application is a continuation in part of application Ser. No. 123,175, now abandoned.

What is claimed is:

1. In a fuel injection nozzle assembly of the type including a nozzle holder, a spring biased spindle reciprocally mounted in the holder and a nozzle secured to the lower end of the holder, the combination comprising: a socket formed in the lower end of said spindle, a truncated spherical ball flattened on its top and bottom sides to present parallel flat surfaces and crimped in said socket for reciprocal movement with said spindle, an upward facing flat sealing surface on the said nozzle in complementary sealing relation to said flat surface on the bottom side of said ball and a motion restraining element secured to said spindle and presenting an abutting surface in confronting relation to said flat surface on the top side of said ball maintaining said flat surfaces in substantially parallel relation to said flat sealing surface.

2. The structure set forth in claim 1 wherein said abutting surface is a conical surface defining a cone whose angle is slightly less than 180 degrees.

3. The structure set forth in claim 2 wherein said restraining element is dowel press fit into a bore of said spindle and presenting said conical surface at its lower end.

4. In a fuel injection nozzle assembly of the type including a nozzle holder, a spring biased spindle reciprocally mounted in the holder and a nozzle secured to the lower end of the holder, the combination comprising: a socket formed in the lower end of said spindle, a truncated ball flattened on its bottom side to present a flat sealing surface and swivelly secured in said socket for reciprocal movement with said spindle, an upward facing flat sealing surface on said nozzle in complementary sealing relation to said flat sealing surface on said ball and motion restraining means associated with said spindle and ball for maintaining said flat sealing surfaces in substantially parallel relation to one another including confronting abutment surfaces on said spindle and ball out of engagement when said sealing surfaces are parallel to one another and in engagement when said sealing surface on said ball is tipped slightly relative to said sealing surface on said nozzle.

5. The structure set forth in claim 4 wherein one of said abutment surfaces is flat and in substantially right angle relationship to the axis of said spindle.

6. The structure set forth in claim 4 wherein the abutment surface on said ball is flat and parallel to said sealing surface on said ball and said means includes a restraining element secured to said spindle presenting the other abutment surface.

7. An injection nozzle assembly comprising an elongated nozzle holder having interior walls defining a bore extending longitudinally therethrough, said walls presenting a cylindrical sealing surface at the upper end of said bore and an enlarged bore portion extending from said sealing surface to the lower end of said holder, a fuel supply passage in said holder opening into the upper end of said enlarged bore portion, a nozzle secured to the lower end of said nozzle holder and presenting a flat

sealing surface in right angle relationship to the axis of said cylindrical sealing surface, a fluid pressure operated valve having an elongated spindle portion presenting a cylindrical sealing surface at its upper end in complementary fluid sealing relation to said sealing surface on said holder, a truncated ball swivelly secured to the lower end of said spindle, said ball presenting a flat sealing surface in complementary sealing relation with a said flat sealing surface presented by said nozzle, means biasing said spindle toward a fuel shutoff position wherein said flat sealing surfaces are in fluid sealing engagement, and motion restraining means associated with said spindle and ball for maintaining said flat sealing surfaces in substantially parallel relation to one another including an abutment surface formed on said ball in parallel relation to said flat sealing surface thereon and a restraining element secured to said spindle and presenting an abutment surface engageable with said abutment surface on said ball upon slight rotary movement of the latter in a direction to cause tipping of said sealing surface on said ball.

8. The structure set forth in claim 7 wherein said restraining element in a dowel press fit in a bore in said spindle.

9. The structure set forth in claim 8 wherein said abutment surface on said dowel defines a cone whose angle is slightly less than 180 degrees.

10. In a fuel injection nozzle assembly of the type including a nozzle holder, a spindle mounted in said holder for reciprocal movement on its axis and a nozzle secured to the lower end of said nozzle holder, the combination comprising: a flat sealing surface formed on said nozzle in right angle relationship to said axis of said spindle, a truncated ball swivelly secured to the lower

end of said spindle, a flat sealing surface formed on said ball in complementary sealing relation with a said flat sealing surface presented by said nozzle, means biasing said spindle toward a fuel shutoff position wherein said flat sealing surfaces are in fluid sealing engagement, and motion restraining means associated with said spindle and ball for maintaining said flat sealing surfaces in substantially parallel relation to one another including spaced abutment surfaces on said ball and spindle brought into abutting engagement with one another by slight rotary movement of said ball in a direction causing tipping of said sealing surface on said ball relative to said sealing surface on said nozzle.

11. The stucture set forth in claim 10 wherein said motion restraining means includes a restraining element secured to said spindle and presenting one of said abutment surfaces, said one abutment surface being symmetrical about an axis passing through the center of said ball.

12. The structure set forth in claim 11 wherein said restraining element is a dowel press fit in a bore in said spindle.

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