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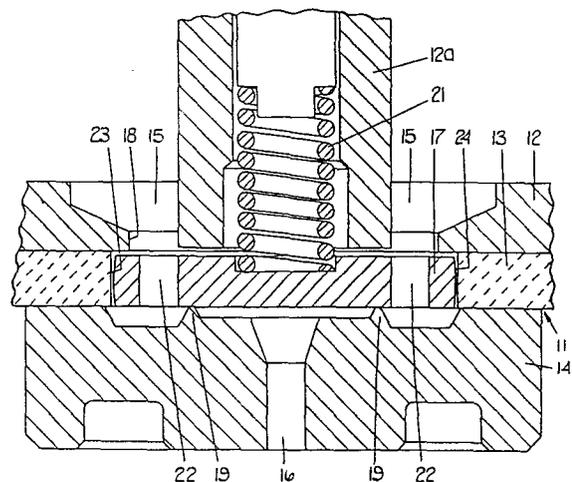
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Fuel injector.

A fuel injector including a body (11) having therein a fuel flow path (15) controlled by a valve incorporating a disc-like closure member (17). The member (17) is guided by an internal circular cylindrical surface (23) of the body for movement between an open position and a closed position. The peripheral surface (24) of the closure member (17) is part-spherical, and co-operates with the internal cylindrical surface (23).



This invention relates to a fuel injector for an internal combustion engine.

In a previously proposed fuel injector the injector body has therein a fuel flow passage terminating at one end in a shaped orifice through which, in use, fuel issues into the inlet manifold of the internal combustion engine. Within the body the fuel flow to the orifice is controlled by a valve including a valve closure member movable relative to a valve seat. Movement of the closure member in one direction to engage the seat, and thus cut off the flow of fuel through the injector, is generated by a spring, and movement in the opposite direction to open the valve is generated by energisation of an electromagnet. In the previously proposed injector the closure member is in the form of a circular disc the peripheral edge of which defines a cylindrical surface. The disc is guided for movement in the direction of the axis of said cylindrical edge surface by a corresponding internal circular cylindrical surface of the injector body.

The use of a closure member having a cylindrical edge surface supported as a sliding fit in a corresponding cylindrical part of the injector body gives rise in particular to ^{two} problems. Firstly it is found to be difficult to assemble the closure member to the body owing to the similarity of the diameters of the closure member and the region of the body within which the closure member is received, and secondly when the closure member is assembled within the body, the presence, in use, of fuel in the bearing defined by the cylindrical surface of the closure member and the internal cylindrical surface of the body impedes the movement of the closure member. It is believed that this latter problem results from "fluid" or "viscous" drag exhibited by the thin film of fuel in the bearing when subjected to shear forces during movement of the closure member relative to the body. It is an object of the present invention to provide an in-

jector of the kind wherein a disc-like closure member is slidably received in the injector body, in which the aforementioned problems are minimised.

A fuel injector according to the invention includes a body having therein a fuel flow path, a valve in said fuel flow path, said valve including a disc-like closure member guided by an internal circular cylindrical surface of the body for movement relative to the body in a direction parallel to the axis of said cylindrical surface, between a closed position wherein the member engages a mating valve seat to prevent fuel flowing through said path, and an open position wherein the member is spaced from said seat to permit fuel flow along said path, the peripheral surface of said closure member, which co-operates with said internal cylindrical surface, being so shaped that considering the member and said cylindrical surface in axial-section (as opposed to cross-section) the peripheral edge of the member includes a region which is curved, with the straight line defined by the axial-section of said cylindrical surface tangential thereto, the peripheral surface of the closure member thus having a peripheral, substantially, line-contact, at its region of greatest diameter, with said internal cylindrical surface.

Conveniently said region of the peripheral surface of said closure member is part-spherical.

Preferably the whole of the peripheral surface of said closure member is part-spherical.

Desirably the centre of curvature of said part spherical surface of the closure member coincides with the centre point of the region of the closure member bounded by said part-spherical surface.

The accompanying drawing is an axial sectional view of part of an injector in accordance with one example of the present invention.

Referring to the drawing the injector includes a multi-part body 11 including a main body 12, an annular bearing plate 13, and a nozzle assembly 14. A fuel flow path 15 extends through the body 11 from an inlet union (not shown) to an outlet orifice 16 defined by the nozzle assembly 14. The bearing plate 13 is interposed between the nozzle assembly 14 and the main body part 12, and the portion of the fuel flow path 15 defined within the main body part 12 communicates with the orifice 16 by way of the central aperture of the annular bearing plate 13. However, within the central aperture of the bearing plate 13 is supported a circular, disc-like valve closure member 17.

The outlet end of the portion of the fuel flow path within the main body part 12 is defined by an annular aperture 18 which is aligned with the central aperture of the plate 13. The orifice 16 of the nozzle assembly 14 is disposed on the axis of the injector, and surrounding the orifice 16 is a raised valve seat 19 against which the closure member 17 is urged by a compression spring 21. The valve closure member 17 is formed with a circular row of through bores 22 which communicate at one end with the annular outlet 18 of the main body part 12. The circular row of through bores 22 lies radially outwardly from the valve seat 19, and thus when the central solid part of the closure member 17 engages the valve seat 19 then flow of fuel from the bores 22 to the orifice 16 is prevented. However, when the closure member 17 is raised from the valve seat 19 fuel can flow from the outlet 18 of the main body part 12, through the bores 22, between the lower face of the closure member 17 and the seat 19, and through the orifice 16 into the inlet tract of the internal combustion engine utilizing the injector.

As previously mentioned the valve defined by the closure member 17 and the seat 19 is closed by the action of the spring 21 which urges the closure member 17 firmly against the seat 19. The valve is opened by energisation of an electromagnet the fixed inner pole of which is defined by a centrally disposed hollow spigot 12_a of the main body part 12, and

the movable armature of which is defined by the closure member 17. As will be apparent from the drawing the spring 21 is housed within the hollow spigot 12a. The electromagnet winding (which is not shown in the drawing) encircles the spigot 12a, and when the winding is energised the closure member 17 which is formed from ferro-magnetic material, is moved towards the lower end of the spigot 12a against the action of the spring 21 to open the valve.

The wall 23 of the central aperture in the plate 13 is cylindrical, and is of circular cross-section, the axis of the cylindrical surface 23 being coincident with the axis of the spigot 12a. The peripheral, outer surface 24 of the closure member 17, for which the surface 23 constitutes a bearing, is part spherical, having its centre of curvature coincident with the centre point of the closure member. Thus the region of the closure member 17 of greatest diameter is on the median plane of the closure member 17 and makes substantially line contact, around the periphery of the closure member 17, with the surface 23. When considered in axial section, (as shown in the drawing) the peripheral edge of the closure member is part circular, and the line defined by the axial section of the cylindrical surface 23 is tangential thereto. It should be noted that in the interests of clarity no contact is shown in the drawing between the surface 24 and the surface 23. In practice however bearing contact can occur and by virtue of the curved nature of the surface 24 the contact between the surface 24 and the surface 23 is restricted to a peripheral, substantially line contact. It will be recognised therefore that on either side of the line of contact between the surface 24 and the surface 23 the closure member is in effect relieved to provide a clearance between the surfaces 23 and 24. This clearance facilitates insertion of the closure member 17 into the aperture of the bearing plate 13 during assembly of the injector, and also minimizes the "fluid" or "viscous" drag on the closure member 17 resulting from the presence of liquid fuel in the bearing

defined between the closure member 17 and the bearing plate 13, by comparison with the drag which would be exhibited by the fuel film in the bearing if the outer peripheral surface of the closure member 17 were cylindrical and a sliding fit in the bearing plate 13.

While it is preferable for the surface 24 of the closure member 17 to be part spherical, having its centre of curvature coincident with the centre of the closure member 17, it is to be understood that it is not essential that the surface 24 is part spherical, and it is not essential that even if the surface 24 is part spherical then its centre of curvature is coincident with the actual centre point of the closure member. For example, it would be possible to produce the closure member 17 having the surface 24 part spherical, but with the centre of curvature of the surface 24 coincident with the centre of one or other of the axial end faces of the closure member 17. In such an arrangement of course the region of greatest diameter of the closure member would be at one or other of the axial ends of the closure member, and all of the clearance between the surface 24 and the surface 23 would be to one side of the peripheral line of contact between the surface 24 and the surface 23. Equally of course the surface 24 may if desired be part ellipsoidal or the like rather than part spherical. Nevertheless, it is preferable for the surface 24 to be part spherical having its centre of curvature coincident with the actual centre of the closure member so that misalignment of the closure member within the plate 13 can be accommodated in use. It will be recognised that in such an arrangement the closure member and plate 13 will act in the manner of a ball and cup joint and the effects of any misalignment will be minimal.

CLAIMS:

1. A fuel injector including a body having therein a fuel flow path, a valve in said fuel flow path, said valve including a disc-like closure member guided by an internal circular cylindrical surface of the body for movement relative to the body in a direction parallel to the axis of said cylindrical surface between a closed position wherein said member engages a mating valve seat to prevent fuel flow along said path, and an open position wherein the member is spaced from said seat to permit fuel to flow along said path characterized in that the peripheral surface 24 of said closure member 17, which co-operates with said internal cylindrical surface 23, being so shaped that considering the member 17 and said cylindrical surface 23 in axial section the peripheral edge of said member 17 includes a region which is curved, with the straight line defined by the axial section of said cylindrical surface 23 tangential thereto, the peripheral surface 24 of the member 17 thus having a peripheral substantially line contact, at its region of greatest diameter, with said internal cylindrical surface 23.
2. An injector as claimed in claim 1 characterized in that said region of the peripheral surface 24 of the member 17 is part-spherical.
3. An injector as claimed in claim 2 characterized in that the whole of the peripheral surface 23 of the member 17 is part-spherical.
4. An injector as claimed in claim 2 or claim 3 wherein the centre of curvature of said part spherical surface 24 of the member 17 coincides with the centre point of the region of the member 17 bounded by said part spherical surface 24.



DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int. Cl. ³)
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	
X	FR - A1 - 2 349 078 (PROENGIN) * page 3, paragraph 2 to page 4; fig. 1,2, positions 5, 17 * --	1-4	F 02 M 51/08 F 16 K 31/06
X	FR - A - 1 289 199 (ELECTRIC AUTO-LITE CO.) * page 3, column 1, paragraph 4 to column 2, paragraph 4; fig. 2, 9, 10, positions 40, 42 * --	1-4	
	US - A - 4 033 513 (LONG) * columns 3 and 4; fig. 2, 4 * --	1,2	TECHNICAL FIELDS SEARCHED (Int. Cl. ³)
	DE - B - 1 264 149 (DAIMLER-BENZ AG) * fig. 2 * --	1-4	F 02 M 51/00 F 02 M 59/00 F 02 M 69/00 F 16 K 31/06
A	DD - A - 97 026 (PETROL INJECTION LTD. et al.) * claim 3; fig. 1, positions 18, 19 * --	1	
A	DE - A1 - 2 412 490 (KUNZ et al.) * pages 3 and 4 * --		CATEGORY OF CITED DOCUMENTS
A	DE - B - 1 500 022 (FORD MOTOR CO.) * column 3, line 30 to column 4, line 57 * --		X: particularly relevant A: technological background O: non-written disclosure P: intermediate document T: theory or principle underlying the invention E: conflicting application D: document cited in the application L: citation for other reasons
A	US - A - 3 412 718 (LONG) * column 3, line 6 to column 4, line 5 * -- ./. .		&: member of the same patent family, corresponding document
X	The present search report has been drawn up for all claims		
Place of search	Date of completion of the search	Examiner	
Berlin	15-12-1980	STÖCKLE	



DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int. Cl.3)
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	
A	US - A - 3 015 325 (WILLIAMS et al.) * column 3, lines 9 to 55 * -----		
			TECHNICAL FIELDS SEARCHED (Int. Cl.3)