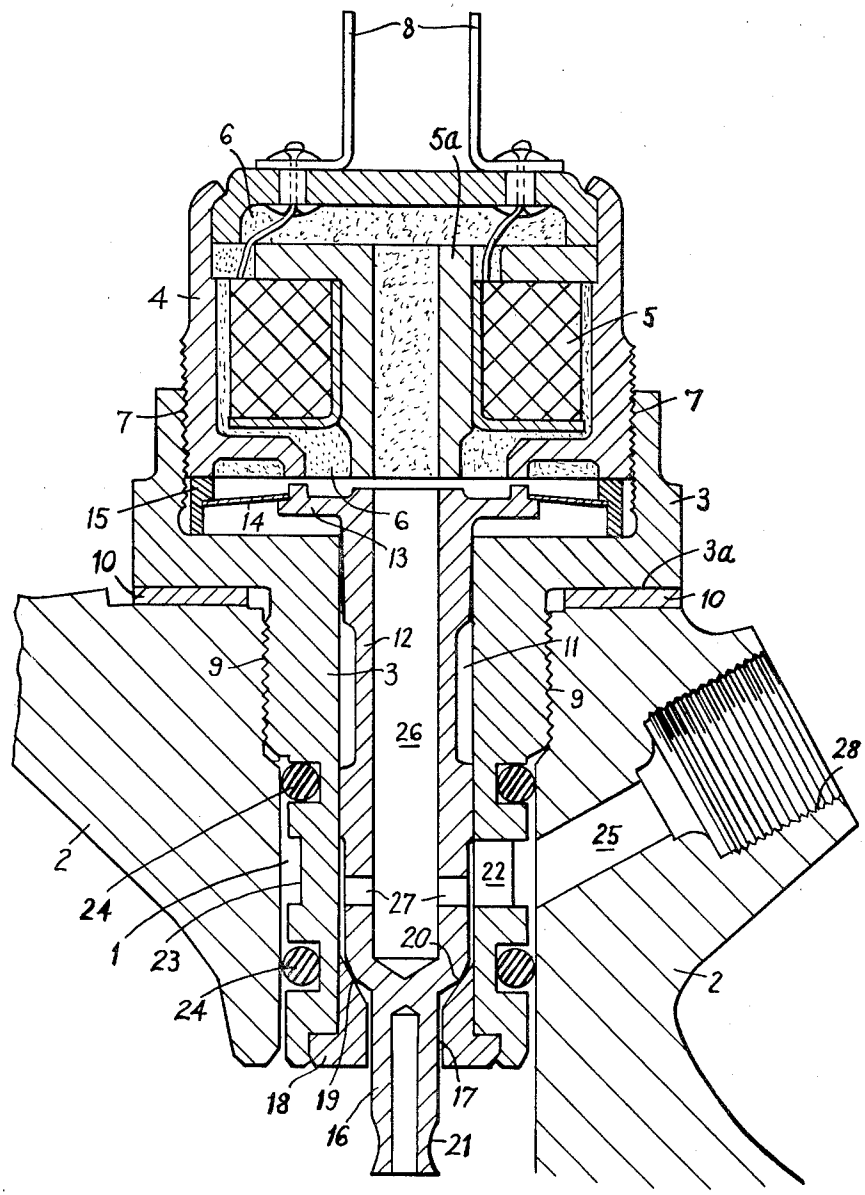
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FUEL INJECTION VALVES

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FUEL INJECTION VALVES

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The present invention relates to fuel injection valves for internal combustion engines.

It is an object of the present invention to provide an improved construction of fuel injection valve, which may be of the electro-magnetically operated type, which can be fitted to or removed from an engine without disturbing the fuel supply line. From one aspect the present invention consists in a fuel injection valve having a valve body part which is adapted to be received within a cavity in an engine which has a fuel feed passage opening into said cavity, wherein said valve body is so constructed that when it is located in position in said cavity a path is provided for the flow of fuel from said passage to the fuel valve contained in said body part and the arrangement is such that said valve can be removed from said cavity without the necessity of mechanically disturbing the fuel supply line.

From another aspect the invention consists in a fuel injection valve having a valve body part which is adapted to be received within a cavity in an engine wherein said part of the body is provided with at least one aperture in its outer surface through which fuel can be fed to the valve.

The invention also consists in an internal combustion engine incorporating at least one fuel injection valve having a valve body part located within a cavity in the engine wherein said valve body part is provided with at least one aperture in its outer surface which communicates with at least one passage provided in a wall of the engine and opening into said cavity, so that fuel fed through said at least one passage passes through said at least one aperture to the valve.

According to a preferred form of the invention, the fuel injection valve is electro-magnetically operated by means of a solenoid attached to the upper part of the valve body whose energisation controls the opening and closing of the valve. The solenoid is formed as a separate assembly which is secured to the upper end of the valve body, for example by means of a screw connection, so that it can be readily removed to acord access to or replacement of the valve, and likewise can be readily replaced with another solenoid assembly if necessary.

In order that the invention may be more fully understood, an embodiment thereof will now be described by way of example, with reference to the accompanying drawing which is a cross-sectional diagram of one embodiment of electro-magnetically operated fuel injection valve according to this invention.

Referring to the drawing, the fuel injection valve as shown mounted within a cavity 1 provided in the wall 2 of the air inlet manifold of an internal combustion engine. The valve comprises a valve body portion 3, at the upper end of which is mounted a solenoid assembly consisting of a coil 5 wound on a core 5*a*. The coil and core assembly are contained within a housing 4 and are encapsulated in a synthetic resin material 6 such as that known under the trademark "Araldite." The solenoid assembly is secured to the valve body 3 by means of the screw connection 7. The electrical connections to the solenoid are made by means of two terminals 8, whereby they are independent of any electrical connection to the casing of the engine and therefore do not rely upon an earth return path through the manifold and engine assembly.

The valve body 3 is screwed into the cavity 1 in the manifold at 9, and a packing washer or gasket 10 is interposed between the shoulder 3*a* on the valve body and the manifold wall 2. The valve body is provided with a bore 11 in which is located a valve stem 12 which is slidable in the bore and whose upper end is formed as an armature 13 which is attracted by the solenoid when it is energised. The armature is attracted against the action of a spring spider 14, surrounding the armature, which normally urges the armature away from the solenoid when the latter is de-energised. The outer periphery of the spider 14 is held by a retaining ring 15.

The valve stem 12 extends downwardly through the bore 11 and its lower end is formed as a nozzle pin 16 which projects through a constant diameter aperture 17 in the member 18. This member provides the valve seating 19 which is engaged by the seating surface 20 formed on the stem 12 to form the fuel valve, which is closed when the two seating surfaces are in engagement. The nozzle pin 16 is of constant diameter and with the constant diameter aperture 17 forms a nozzle metering device. The tip of the nozzle pin 16 is shaped as shown at 21.

A plurality of apertures 22, for example three, are provided in a recess or gallery 23 extending around the valve body part 3 and communicate with the bore 11. Sealing rings 24 are located in grooves in the valve body part 3 both above and below the recess or gallery 23 in order to form fluid-tight joints. Fuel is fed to the valve through the passage 25 provided in the manifold wall 2. This passage communicates with the gallery 23 and the apertures 22 so that the fuel passes into the bore 11 and flows around the stem 12 of the valve. When the valve is opened by energisation of the solenoid, the armature 13 is attracted against the action of the spring 14, thereby causing the valve stem 12 to slide upwardly so separating the seating surfaces and allowing fuel to pass out through the annular space 17 surrounding the nozzle pin.

As is shown at 26, the valve stem is hollow and apertures 27 are provided through the wall of the stem so that fuel can also flow through these apertures, up the central hollow portion of the stem to both sides of the armature 13. This arrangement reduces pumping effects on the fuel when the valve is operated.

The calibration of the annular metering orifice 17 between the nozzle pin 16 and the wall of the aperture is dependent on the length/diameter ratio of the orifice, the total orifice area and the base diameter of the pin. With these values correctly proportioned, the assembly provides a stable meter facility so long as the flow area at the valve is greater than the metering area considered in accordance with the relevant coefficients of discharge and the operating pressures. The fuel thus metered flows in a seemingly laminar manner along the nozzle pin until it reaches the shaped end 21 at which atomization occurs.

It will be seen that with the construction according to the present invention, it is possible to insert an injection valve into and remove it from the engine without disturbing the fuel supply line, which is not directly connected to the valve, but is connected at 28 to the passage 25 in the inlet manifold.

Thus the fuel supply line feeding the injection valve can be permanently attached to the air manifold and the connection does not have to be broken when it is desired to change a fuel injection valve, thus reducing the possibility of leakage.

It will also be seen that the magnetic circuit comprising the solenoid coil and its core forms a separate assembly from the valve stem and nozzle pin assembly.

Either of these assemblies can therefore easily be changed to suit the requirements of any particular engine.

Whilst a particular embodiment has been described, it will be understood that various modifications can be made without departing from the scope of this invention. Thus, although the invention has been described as applied to an electro-magnetically operated fuel injection valve, many of its features may also be applied to valves operated by other means. Moreover, it is not essential that the body of the valve should be screw-threaded into the cavity. It is sufficient that the valve may be held in position by means of a light pressure, such as a spring, since the presure in the air inlet manifold is never above atmospheric pressure.

It will also be understood that, in practice, a multi-cylinder internal combustion engine will generally comprise a plurality of fuel injection valves, each of which may be constructed and arranged according to the invention.

We claim:

1. A fuel injection valve having a valve body provided with a bore and adapted to be received within a cavity in an engine, a valve stem slidable within the bore, a valve member including a part of the valve stem and operated by the movement of the valve stem, a recess surrounding a portion of the valve body which is to be received in said engine cavity, and located towards that end of the valve body which surrounds the valve member, at least one aperture extending from said recess into said bore to feed fuel from a fuel passage communicating with said cavity through said recess into said bore, sealing means surrounding said valve body on either side of said recess, an armature at the end of said stem remote from said valve member, a solenoid conected to said valve body at its end remote from the valve member for attracting said armature to open the valve and means operable on said armature against the attractive force of said solenoid to close the valve.

2. A fuel injection valve as claimed in claim 1, in which the valve member for controlling the flow of fuel comprises a seating surface on said stem which engages with a seating associated with the bore in which the stem slides in order to close the valve.

3. A fuel injection valve as claimed in claim 1, in which the valve stem is made hollow and is provided with at least one opening through which fuel can flow from the bore into the hollow stem in order to reduce the pumping effect on the fuel during the operation of the valve.

4. A fuel injection valve having a valve body provided with a bore and adapted to be received within a cavity in an engine, a valve stem slidable within the bore, a valve member including a part of the valve stem and operated by the movement of the valve stem, a recess surrounding a portion of the valve body which is to be received in said engine cavity and located towards that end of the valve body which surrounds the valve member, at least one aperture extending from said recess into said bore to feed fuel from a fuel passage communicating with said cavity through said recess into said bore, sealing means surrounding said valve body on either side of said recess, an armature at the end of said stem remote from said valve member, a solenoid detachably connected to said valve body at its end remote from the valve member for attracting said armature to open the valve, spring means operable on said armature against the attractive force of said solenoid to close the valve and electrical connections to said solenoid which are insulated from the valve body.

5. A fuel injection valve having a valve body provided with a bore and adapted to be received within a cavity in an engine, a valve stem slidable within the bore, a valve member including a part of the valve stem and operated by the movement of the valve stem, a recess surrounding a portion of the valve body which is to be

received in said engine cavity and located towards that end of the valve body which surrounds the valve member, at least one aperture extending from said recess into said bore to feed fuel from a fuel passage communicating with said cavity through said recess into said bore, sealing means surrounding said valve body on either side of said recess, a hollow portion within said stem, at least one aperture connecting this hollow portion to said bore, an armature at the end of said stem remote from said valve member, a solenoid connected to said valve body at its end remote from the valve member for attracting said armature to open the valve and means operable on said armature against the attractive force of said solenoid to close the valve.

6. A fuel injection valve having a valve body provided with a bore and adapted to be received within a cavity in an engine, a valve stem slidable within the bore, a valve member including a part of the valve stem and operated by the movement of the valve stem, a recess surrounding a portion of the valve body which is to be received in said engine cavity and located towards that end of the valve body which surrounds the valve member, at least one aperture extending from said recess into said bore to feed fuel from a fuel passage communicating with said cavity through said recess into said bore, sealing means surrounding said valve body on either side of said recess, a hollow portion within said stem, at least one aperture connecting this hollow portion to said bore, an armature at the end of said stem remote from said valve member, a solenoid detachably connected to said valve body at its end remote from the valve member for attracting said armature to open the valve, spring means operable on said armature against the attractive force of said solenoid to close the valve and electrical connections to said solenoid which are insulated from the valve body.

7. In an internal combustion engine having an inlet manifold, at least one fuel injection valve having a valve body provided with a bore and adapted to be received within a cavity in said inlet manifold, a valve stem slidable within the bore, a valve member including a part of the valve stem and operated by the movement of the valve stem, a recess surrounding a portion of the valve body located in said cavity, said recess being located towards that end of the valve body which surrounds the valve member, a fuel passage extending through the wall of said manifold to said recess, at least one aperture extending from said recess into said bore to feed fuel from said fuel passage through said recess into said bore, sealing means surrounding said valve body on either side of said recess, an armature at the end of said stem remote from said valve member, a solenoid connected to said valve body at its end remote from the valve member for attracting said armature to open said valve and means operable on said armature against the attractive force of said solenoid to close the valve.

8. In an internal combustion engine having an inlet manifold, at least one fuel injection valve havig a valve body provided with a bore and adapted to be received within a cavity in said inlet manifold, a valve stem slidable within the bore, a valve member including a part of the valve stem and operated by the movement of the valve stem, a recess surrounding a portion of the valve body located in said cavity, said recess being located towards that end of the valve body which surrounds the valve member, a fuel passage extending through the wall of said manifold to said recess, at least one aperture extending from said recess into said bore to feed fuel from said fuel passage through said recess into said bore, sealing means surrounding said valve body on either side of said recess, a hollow portion within said stem, at least one aperture connecting this hollow portion to said bore, an armature at the end of said stem remote from said valve member, a solenoid detachably connected to said valve body at its end remote from the valve member for attracting

said armature to open said valve and means operating on said armature against the attractive force of said solenoid to close the valve.

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