

[72] Inventor **Horst Gebert**
Stuttgart-Feuerbach, Germany
 [21] Appl. No. **793,648**
 [22] Filed **Jan. 24, 1969**
 [45] Patented **Mar. 2, 1971**
 [73] Assignee **Robert Bosch G.m.b.H.**
Stuttgart, Germany
 [32] Priority **Jan. 30, 1968**
 [33] **Germany**
 [31] **P 16 01 395.9**

3,241,768 3/1966 Croft..... 239/585X
 3,301,492 1/1967 Kingsley..... 239/535
 3,329,347 7/1967 Montgomery..... 239/585X

FOREIGN PATENTS

702,797 1/1954 Great Britain..... 239/533

Primary Examiner—M. Henson Wood, Jr.

Assistant Examiner—John J. Love

Attorney—Michael S. Striker

[54] **ELECTROMAGNETICALLY OPERATED FUEL INJECTION VALVE**
10 Claims, 4 Drawing Figs.

[52] U.S. Cl..... **239/585,**
239/464, 239/533
 [51] Int. Cl..... **B05b 1/30**
 [50] Field of Search..... **239/585,**
86—96, 533, 535, 462, 464

References Cited

UNITED STATES PATENTS

2,881,980 4/1959 Beck et al..... 239/585X

ABSTRACT: An electromagnetically operated fuel injection valve wherein the armature has an annular sealing surface surrounded by an annular chamber and is normally biased against the rear side of a nozzle. The chamber receives fuel by way of one or more channels which extend from the peripheral surface of the armature toward the bottom surface of the channel so that their projections into the plane of the sealing surface are tangential to the chamber. This causes fuel which enters the chamber to circulate therein whereby the magnitude of the axial component of movement of the fuel determines the rate at which the fuel enters the orifice of the nozzle when the electromagnet is energized to retract the armature from the nozzle.

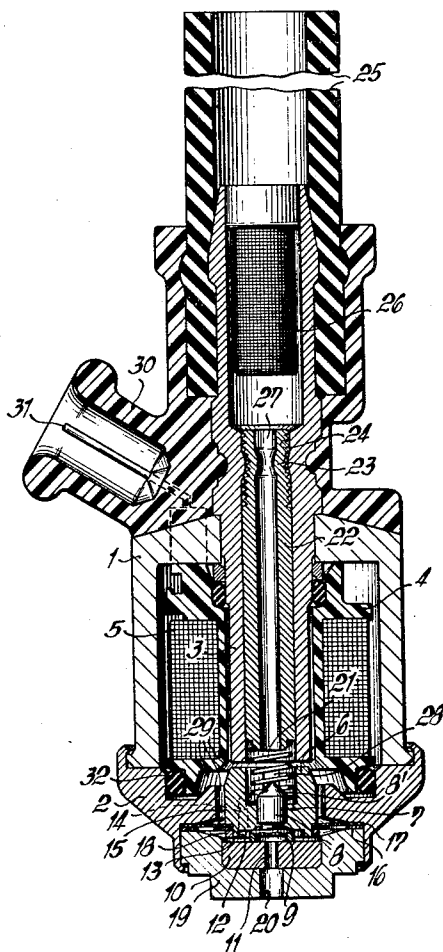
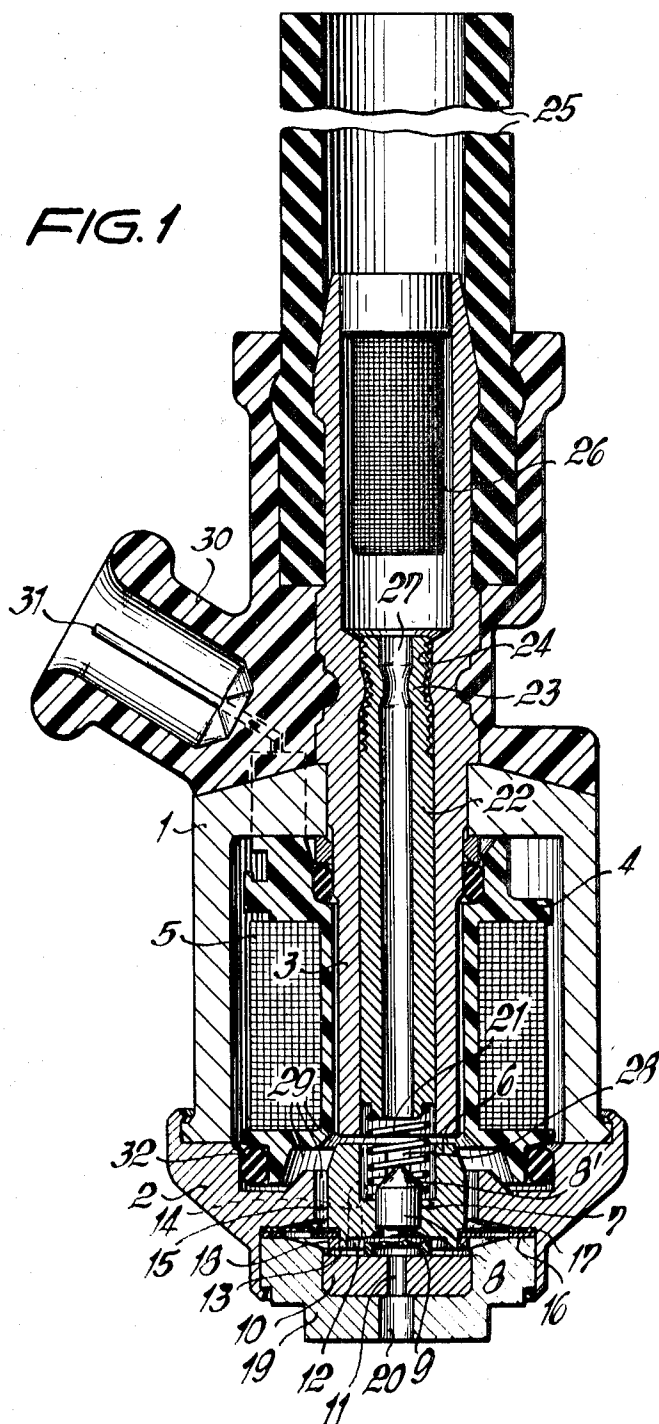


FIG. 1



INVENTOR
Horst GEBERT
BY

Michael S. Stinker
his ATTORNEY

FIG. 2

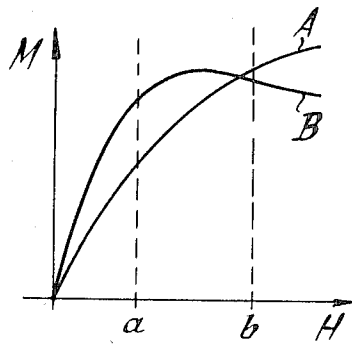


FIG. 3

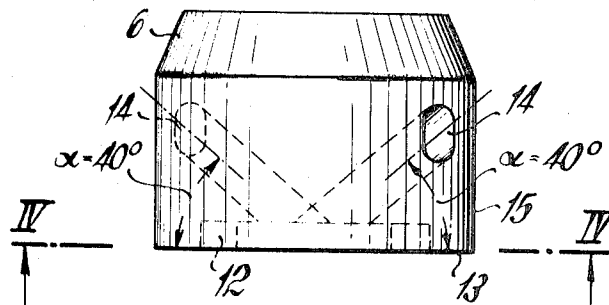
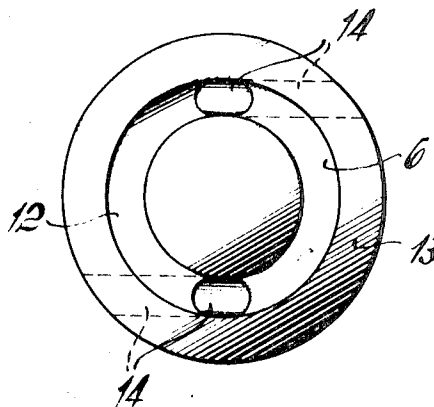


FIG. 4



INVENTOR
Horst GEBERT
BY

Michael S. Huker
his ATTORNEY

ELECTROMAGNETICALLY OPERATED FUEL INJECTION VALVE

BACKGROUND OF THE INVENTION

The present invention relates to electromagnetically operated valves in general, and more particularly to improvements in electromagnetically operated valves which are especially suited to inject fuel into the intake manifold of an internal combustion engine, particularly into an engine wherein the injection of fuel takes place by means of a time-controlled low-pressure fuel injection system.

An important requirement for satisfactory operation of fuel injection valves is that the amounts of fuel which are to be injected in response to identical (and particularly in response to very short lasting) voltage impulses should be reproducible with a high degree of accuracy. In certain presently known fuel injection valves, the rate of fuel discharge is determined by accurately calibrated fuel injection orifices. The nozzles of such valves must be machined with a very high degree of precision which involves considerable manufacturing and testing costs. Furthermore, depositions of foreign matter in such orifices exert a very pronounced influence on the rate of fuel delivery.

A typical electronically controlled fuel injection system for such injection valves is disclosed in Scholl, U.S. Pat. No. 3,372,680.

SUMMARY OF THE INVENTION

One object of my invention is to provide a novel and improved electromagnetically operated fuel injection valve which is capable of discharging accurately measured amounts of fuel even if its nozzle is not machined with a high degree of precision.

Another object of the invention is to provide a valve whose operation is much less dependent on fluctuations in viscosity of fuel than the operation of conventional valves.

A further object of the invention is to provide a valve wherein the angle of divergence of the fuel spray which issues from the orifice of the nozzle can be regulated within a wide range and in a simple and inexpensive way.

An additional object of the invention is to provide a valve wherein the rate of fuel discharge is practically independent of the cross-sectional area of the conduit which delivers fuel to the point immediately upstream of the orifice in the nozzle.

The novel valve comprises electromagnet means including a soft iron core and coil means surrounding the core, a nozzle having a fluid-discharging orifice, an armature coaxially disposed between the core and the nozzle and having an annular sealing surface which normally abuts against the rear side of the nozzle to seal the orifice from an annular chamber provided in the armature and surrounding the sealing surface, the chamber being in communication with the orifice in response to axial movement of the armature away from the nozzle on energization of the electromagnet means, and means for admitting fluid to the chamber including at least one channel provided in the armature and being inclined inwardly toward and communicating with the chamber. The projection of the channel into the plane of the sealing surface is at least nearly tangential to the chamber. This insures that the fluid which enters the chamber is set in circulatory motion whereby its movement includes a first component in circumferential direction and a second component in axial direction of the armature. The second component determines the rate of fluid flow into the orifice when the electromagnet means is energized.

The novel features which are considered as characteristic of the invention are set forth in particular in the appended claims. The improved valve itself, however, both as to its construction and its mode of operation, together with additional features and advantages thereof, will be best understood upon perusal of the following detailed description of a specific embodiment with reference to the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is an axial sectional view of an electromagnetically operated fuel injection valve which embodies the invention, the armature of the valve being shown in sealing position;

FIG. 2 is a graph showing the rates of fuel discharge from a conventional valve and from the valve of FIG. 1;

FIG. 3 is an enlarged side elevational view of a portion of the armature in the valve of FIG. 1; and

FIG. 4 is a bottom plan view as seen in the direction of arrows from the line IV-IV of FIG. 3.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The electromagnetically operated fuel injection valve of FIG. 1 comprises a housing or body which includes a cupped main portion 1 and a cover portion 2. The cupped portion 1 accommodates the electromagnet which includes a hollow soft iron core 3, a plastic coil support 4 and a coil 5. The means for supplying current to the coil 5 comprises a male terminal 31 which is surrounded by a socket 30 of synthetic plastic material. The cover portion 2 of the valve housing accommodates a reciprocable valve member 6 which is coaxial with the core 3 and is provided with an axially extending bore or passage 7 for a hardened cylindrical sealing member or plug 8 which, together with the valve member 6, constitutes the armature of the electromagnet. The plug 8 has an annular sealing surface 9. The front end portion of the valve member 6 is adjacent to a nozzle 10 which is provided with an axially extending orifice 11. That (front) end face 13 of the valve member 6 which is adjacent to the nozzle 10 is provided with an annular groove or chamber 12 which communicates with the discharge ends of two inclined channels 14 and surrounds the sealing surface 9. The channels 14 extend in part in the peripheral surface 15 of the valve member 6 and thereupon inwardly and forwardly toward the chamber 12. A slitted leaf spring 16 serves to support the valve member 6 for reciprocatory movement without friction. This leaf spring 16 is located in front of a flexible diaphragm 17 of synthetic plastic material which prevents escape of fuel through the slits. The central portion of the parts 16, 17 are secured to the valve member 6 by a clamping ring 18 which surrounds the front end face 13, and the marginal portions of the parts 16, 17 are clamped between an internal shoulder of the cover portion 2 and a cap 19 which overlies the front side of the nozzle 10. The means for maintaining the valve member 6 in closed or sealing position comprises a helical spring 21 which bears against an internal shoulder of the valve member and reacts against an axially adjustable sleeve-like retainer 22 installed in the core 3. The rear portion 8' of the plug 8 extends into the foremost convolutions of the spring 21. The rear end portion 23 of the sleeve 22 is provided with external threads 24 and, once the sleeve is properly adjusted to determine the bias of the spring 21, its rear end portion is held against axial movement by suitable deformation of the surrounding part of the core 3.

THE OPERATION

Fuel is admitted by way of a supply conduit 25 which is sealingly coupled to the socket 30 rearwardly of the sleeve 22. The fuel then passes through a filter 26 in the rear end portion of the core 3, through a median portion of the core, through the central passage 27 of the sleeve 22, through radially outwardly extending slots 28 of the sleeve 22, and into an annular compartment 29 between the valve member 6 and the cover portion 2 of the valve housing. A sealing ring 32 is inserted between the parts 2 and 4 to prevent leakage of fuel to the coil 5. The aforementioned inclined channels 14 connect the compartment 29 with the annular chamber 12 in the front end face 13 of the valve member 6. The chamber 12 is sealed by surface 9 from the orifice 11 of the nozzle 10 when the coil 5 is deenergized. When the circuit of the coil 5 is completed and the electromagnet is energized, the valve member 6 is retracted from the nozzle 10 against the opposition of the spring 21 so that fuel can flow radially inwardly along the seal-

ing surface 9 of the plug 8 and into the orifice 11. Additional fuel enters the chamber 12 by way of the channels 14.

The configuration of channels 14 in the valve member 6 is shown in FIGS. 3 and 4. The intake end of each channel 14 is located in the peripheral surface 15 of the valve member, and each channel 14 thereupon extends inwardly and forwardly along an inclined path so that the inclination of its axis with reference to the front face 13 of the valve member remains constant or substantially constant. This is indicated by the angles α which equal 40° . As shown in FIG. 4, the discharge ends of the channels 14 are located in the bottom surface of the annular chamber 12 in the front end face 13 of the valve member 6. FIG. 4 further shows that the projections of channels 14 into the plane of the front end face 13 are tangential to the annular chamber 12 and that the discharge ends of these channels are located diametrically opposite each other with reference to the axis of the valve member. Such formation of channels 14 insures that fuel which is admitted into the chamber 12 begins to rotate whereby the movement of fuel includes a component in circumferential direction and a component in axial direction of the valve member. The width of the gap between the sealing surface 9 and the rear surface of the nozzle 10 in energized condition of the electromagnet is constant. Therefore, the rate of outflow of fuel decreases if the component of movement in circumferential direction of the valve member increases. The axial component of fuel flow determines the rate at which the fuel enters the orifice 11.

The relationship between axial and circumferential components of movement of fuel in the chamber 12 will be best understood with reference to the diagram of FIG. 2. The curve A indicates the amounts M of fuel which leave the nozzle per unit of time as a function of the stroke H of the armature in conventional fuel injection valves wherein the fuel flows toward the sealing surface radially inwardly or in parallelism with the axis of the armature. The curve B indicates the rate of fuel flow through the valve of the present invention, i.e., through a valve where the fuel is caused to circulate before it reaches the sealing surface 9. In the region between the values a and b of the stroke H of the valve member 6, the rate of fuel outflow is practically constant. In this region, the rate of fuel flow is independent of the cross-sectional area of the channels 14.

Another important advantage of the improved valve is that it allows for corrections in the rate of fuel flow in dependency on changes in viscosity of fuel. It was found that, because the fuel circulates in the chamber 12 upstream of the sealing surface 9, the effect of changes in viscosity of fuel on the rate of outflow is much less pronounced than in conventional electromagnetic fuel injection valves. This is attributed to the tangential component of movement of fuel in the chamber 12.

An important function of the cap 19 is that it restricts the angle of divergence of the conical fuel spray which issues from the orifice 11. The cap 19 is provided with a central aperture 20 which registers with the orifice 11. Depending on the type of engine in which the valve is being put to use, one can select an appropriate cap 19 to insure that the angle of the conical fuel spray is best suited for injection of fuel into the particular engine.

Since the leaf spring 16 supports the valve member 6 for reciprocatory movement without friction, the spring 21 is capable of maintaining the surface 9 of the plug 8 in perfect sealing engagement with the nozzle 10 when the electromagnet is deenergized.

Still another important advantage of the improved valve is

that it reacts practically without any delay to deenergization of the electromagnet. This is attributed to the fact that the magnetic resistance in the gap between the cover portion 2 and the valve member 6 exceeds considerably the magnetic resistance between the valve member 6 and the soft iron core 3. Also, during energization of the electromagnet, the magnetic flux remains practically unchanged.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can, by applying current knowledge, readily adapt it for various applications without omitting features which fairly constitute essential characteristics of the generic and specific aspects of my contribution to the art.

I claim:

1. A valve, particularly for injection of fuel into the intake manifold of an internal combustion engine, comprising electromagnet means including a core and coil means surrounding said core; a nozzle located in front of and spaced from said core and having a planar rear face and a fluid-discharging orifice extending forwardly from said rear face; an armature installed between said core and said nozzle and having an annular planar sealing surface normally abutting against said planar rear face of said nozzle to seal said orifice from an annular chamber provided in said armature and surrounding said sealing surface, said chamber being in communication with said orifice in response to movement of said armature away from said nozzle on energization of said electromagnet means; and means for admitting fluid to said chamber, including at least one channel provided in said armature and being inclined inwardly toward and communicating with said chamber, the projection of said channel into the plane of said sealing surface being at least substantially tangential to said chamber.

2. A valve as defined in claim 1, wherein said armature has a peripheral surface and said channel has a receiving end in said peripheral surface.

3. A valve as defined in claim 1, wherein said armature is reciprocable substantially without friction between said core and said nozzle, and further comprising guide means for guiding said armature during movement relative to said nozzle.

4. A valve as defined in claim 3, further comprising a housing for said electromagnet means and said armature, said guide means comprising a slitted leaf spring connected between said housing and said armature.

5. A valve as defined in claim 4, further comprising flexible diaphragm means sealingly connected with said armature and said housing at one side of said leaf spring.

6. A valve as defined in claim 1, further comprising means for permanently biasing said armature against said nozzle.

7. A valve as defined in claim 6, wherein said biasing means comprises a helical spring operating between a centrally located portion said armature and an adjusting member installed in said core.

8. A valve as defined in claim 1, further comprising a cap located in front of said nozzle and having a centrally located aperture in registry with said orifice.

9. A valve as defined in claim 8, wherein the diameter of said aperture exceeds the diameter of said orifice.

10. A valve as defined in claim 1, wherein the fluid admitted into said chamber by way of said channel is caused to circulate in said chamber and has a first component of movement in the circumferential direction and a second component of movement in the axial direction of said armature, said second component determining the rate at which fluid enters said orifice in response to energization of said electromagnet means.