Oct. 17, 1961 H. KNAPP ET AL 3,004,720

FUEL INJECTION VALVE ARRANGEMENT

Filed Sept. 21, 1959 2 Sheets-Sheet 1

FIG. 1

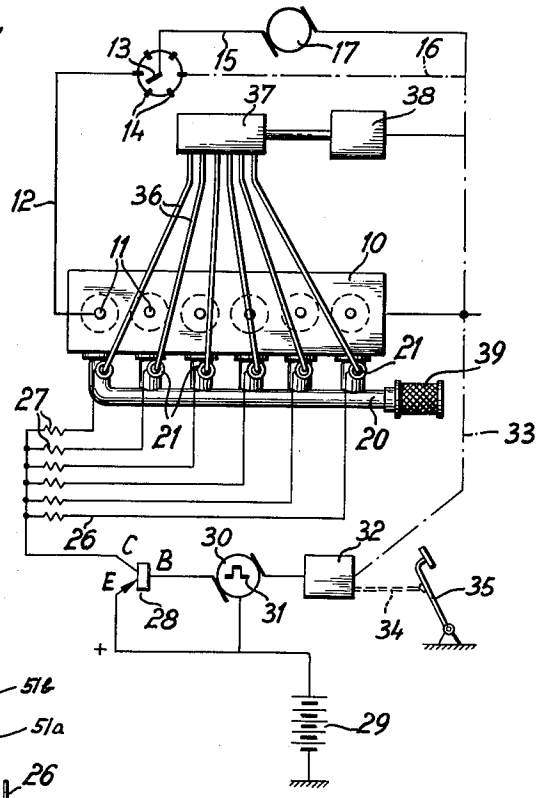
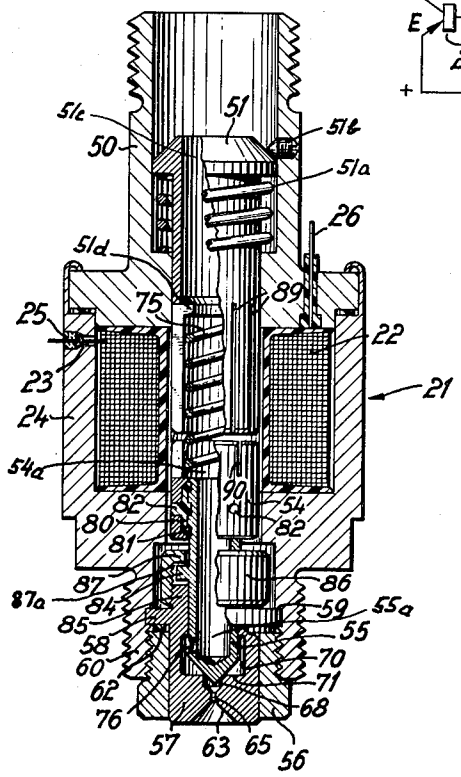


FIG. 2



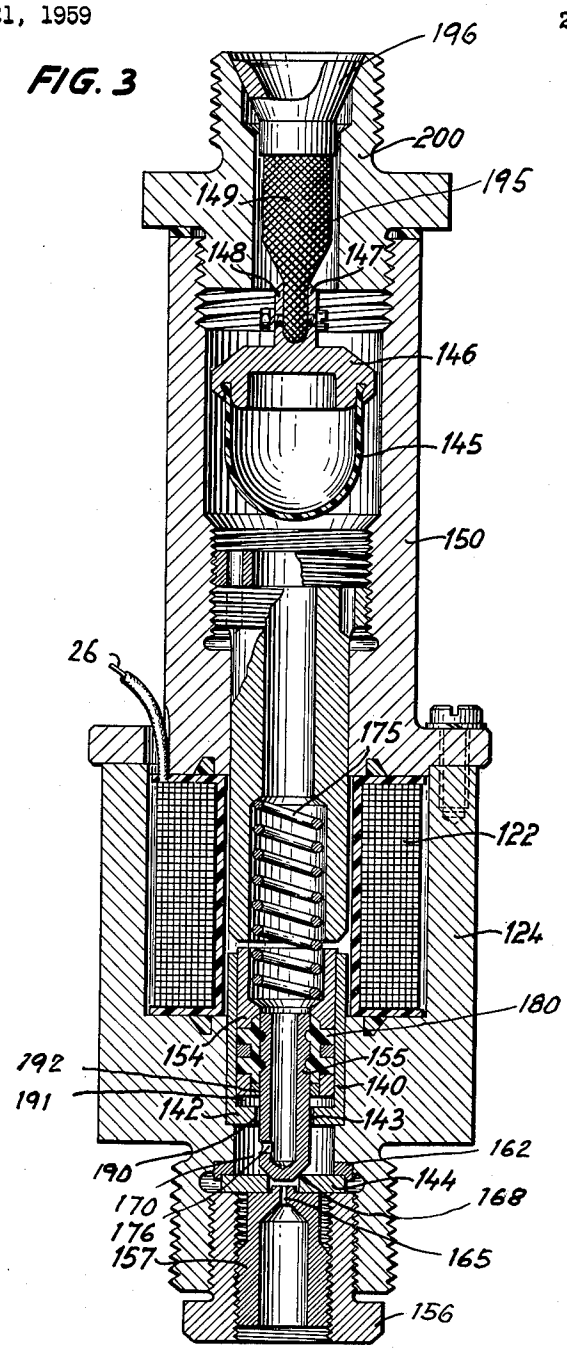
INVENTORS
Heinrich Knapp
and Leo Steinke
By: Michael S. Striker
Attorney

Oct. 17, 1961 H. KNAPP ET AL 3,004,720

FUEL INJECTION VALVE ARRANGEMENT

Filed Sept. 21, 1959 2 Sheets-Sheet 2

FIG. 3



INVENTORS
Heinrich Knapp
and Leo Steinke
by: Michael S. Striker
Attorney

United States Patent Office 3,004,720 Patented Oct. 17, 1961

3,004,720

FUEL INJECTION VALVE ARRANGEMENT

Heinrich Knapp and Leo Steinke, Stuttgart, Germany, assignors to Robert Bosch G.m.b.H., Stuttgart, Germany

Filed Sept. 21, 1959, Ser. No. 841,081
Claims priority, application Germany Sept. 24, 1958
13 Claims. (Cl. 239—585)

The present invention relates to a fuel injection valve arrangement, and more particularly to a fuel injection valve including a needle valve means operated by the movable armature of an electromagnetic means.

It is important for the proper operation of a fuel injection valve that the movements of the valve needle to and from the position closing the discharge duct takes very little time, and that the mass of the movable parts is as small as possible. Furthermore, it is very desirable that a very tight closure of the discharge duct is obtained by the movable valve means, and that such closure is maintained until the commencement of the following fuel injection, since otherwise the amount of injected fuel varies.

The known valve arrangements do not obtain a reliable closure of the discharge duct by the movable valve means, since the valve means does not fit perfectly on the valve seat, particularly after the valve seats are worn due to the sharp impacts of the valve means on the valve seat. Furthermore, in the valve arrangements of the prior art, the impact of the valve means on the valve seat is sometimes so sharp that the valve means bounces back and the valve is again opened and closed which results in inaccuracies regarding the injection time, the amount of injected fuel, and fuel consumption.

It is one object of the present invention to overcome the disadvantages of the valve arrangements according to the prior art, and to provide a valve arrangement, particularly suited for fuel injection arrangements, in which the valve tightly closes even after extended use.

Another object of the present invention is to provide a valve arrangement in which the valve means cannot bounce back from the valve seat.

A further object of the present invention is to provide a needle valve means capable of tightly closing a valve seat with which it is not exactly aligned.

A further object of the present invention is to provide a valve arrangement in which a needle valve means is dampened by movement of a portion thereof in a chamber containing a liquid, such as liquid fuel.

A further object of the present invention is to provide a fuel injection arrangement including a plurality of injection valves and including means for equalizing the pressure of the liquid fuel in each of the fuel injection valves.

A further object is to provide a light valve means which is operated by a strong magnetic flux.

A still further object is to provide an adjustable and removable armature for electro magnetic means which operate the valve means.

With these objects in view, the present invention mainly consists in a valve arrangement which is advantageously used in a fuel injection system for a combustion engine, and comprises valve body means including a discharge portion formed with a discharge duct; valve means mounted in the valve body means for movement to and from a closing position engaging a valve seat for closing the discharge duct; a movable actuating member, for example a magnetizable armature; a resilient member, preferably consisting of a thermoplastic synthetic material and connecting the actuating member with the valve means for movement therewith; and operating means, such as electromagnetic means, for reciprocating the actuating armature member. Since the resilient member is provided between the armature member and the valve means, the impact of the valve means on the valve seat is cushioned by the resilient member, and furthermore, the resilient member permits a transverse movement of the valve member into a position fully engaging the valve seat for closing the discharge duct.

In the preferred embodiment of the present invention, the resilient member is a tubular block connecting a tubular armature member with a needle valve means and consisting of a polyamide, such as nylon.

Preferably, a chamber for the liquid fuel which is controlled by the valve means is provided in the valve body, and the valve means has a portion projecting into the chamber and being dampened by the liquid fuel therein. The damping chamber communicates with a throttling duct through which the liquid fuel is pressed during movement of the needle valve means to the closing position.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawings, in which:

FIG. 1 is a schematic diagram illustrating a fuel injection arrangement for a combustion engine;

FIG. 2 is a longitudinal sectional view illustrating a valve arrangement according to one embodiment of the present invention; and

FIG. 3 is a longitudinal sectional view illustrating a modified valve arrangement according to another embodiment of the present invention.

Referring now to the drawings, and more particularly to FIG. 1, a six cylinder combustion engine **10** has six spark plugs **11**, each of which is connected by a cable **12** to a distributor including a rotary contact arm **13** and six stationary contacts **14**. A cable **15** connects the shaft of the distributor arm **13** with a high voltage generator **17** which produces a spark impulse for each cycle of the combustion engine. Distributor arm **13** is connected by shaft **16** to the crank shaft, not illustrated, of the combustion engine. Each cylinder of the combustion engine is provided in a known manner with an inlet valve communicating with branch pipes of a common air inlet **20** terminating in an air filter **39**.

An injection valve **21** is located in each branch pipe, and such injection valves **21** are either of the type illustrated in FIG. 2, or of the type illustrated in FIG. 3. In both embodiments, an electromagnetic winding **22**, and **122**, respectively, is provided which has one terminal connected to mass, and an insulated terminal **26**. Terminals **26** are connected through resistors **27** to a common conductive line connected to a transistor **28**.

The emitter electrode E of the transistor is connected to a battery **29** whose other terminal is connected to mass. The base electrode B of transistor **28** is connected to an impulse generator **30** which produces electric impulses in rapid succession, as schematically indicated at **31**. The impulses render the normally non-conductive transistor **28** conductive, so that it opens permitting current from battery **29** to pass simultaneously through resistors **27**, and the electromagnetic windings **22** (**122**) of all six injection valves **21**. Since the valves illustrated in FIGS. 2 and 3 remain open as long as the electromagnetic windings are energized, the fuel amounts injected into the combustion engine are the greater, the longer the impulses of the impulse generator **30** last.

An electronic control device **32** is provided for varying the length of the impulses in accordance with the fuel requirements of the combustion engine **10**. The control device **32**, which is not an object of the present invention, includes electrical means which are mechanically con-

nected by linkages 33, and 34, respectively, with the crank shaft of the combustion engine 10, and with the gas pedal 35 by which the operator controls the combustion engine. The control device 32 includes other means, not illustrated, for influencing the time periods of the impulses in accordance with the barometric pressure, the temperature of the cooling water of the combustion engine, and with the air temperature.

Each injection valve 21 is connected by one of the fuel supply tubes 36 to a container 37 for liquid fuel in which the fuel is maintained under substantially constant pressure by a pump 38, driven from the combustion engine as schematically indicated in FIG. 1.

Every time a valve 21 opens, fuel is injected onto the plate of the respective valve of the combustion engine, and is admixed to the air entering the respective cylinder and supplied by air inlet pipe 20.

Referring now to the valve arrangement illustrated in FIG. 2, a fuel injection valve 21 has valve body means 24 in which a needle valve means 55 is provided for opening and closing the discharge duct 65 which communicates with one of the cylinders of the combustion engine. The inlet means 50 is provided with thread, and is adapted to be connected to one of the fuel supply tubes 36. An electromagnetic winding 22 is secured to the valve body, and has one terminal 23 soldered at 25 to the valve body 24, and another terminal 26 insulated by a tubular insulating member from the valve body and passing out of the valve body to be connected to a resistor 27, as described above.

The tubular stationary core member 51 is partly located in the inlet portion 50, and partly within the winding 22. A spring 51*a* urges core member 51 against a screw 51*b* so that the position of core member 51 is determined. A conduit 51*c* passes through member 51, and an inner flange 51*d* projects into conduit 51*c*. Longitudinal slots 89 prevent the development of circumferential currents in the tubular core member 51. The needle valve means 55 has a conical front end cooperating with a valve seat on a nozzle member 57 which is held on a threaded portion 60 of the valve body by a threaded member 56. Nozzle member 57 has a flange 58, and a sealing ring 62 is provided between the threaded member 56 and flange 58. Flange 58 abuts against a shoulder 59 in the threaded part 60 of the valve body 24.

Nozzle member 57 has on its front end a conical recess 63 into which discharge duct 65 opens. Discharge duct 65 is as short as possible so that only very little liquid fuel remains in the nozzle at the closing of the valve by needle valve means 55. A larger bore 68 is connected by conical bore with discharge duct 65, and forms a circular edge with the flat surface 71 which is one wall of an annular chamber 70 surrounding the head of needle valve means 55. A tubular armature member 54 is located in the valve body 24 and is coaxial with the stationary core member 51 and with the hollow needle valve means 55. Armature member 54 is provided with slots 90 to prevent the development of circumferential currents. The tubular armature member 54 is fixedly secured to the needle valve means 55 by a resilient member 82 which is located between the overlapping portions of members 54 and 55. Three annular grooves 81 are formed in the outer surface of valve means 55 and are filled with matching annular ridges of resilient member 80, the annular ridges having projecting parts located in several bores 82 which are distributed about the circumference of armature member 54.

In accordance with the present invention, the resilient member 82 consists of a thermoplastic material, for example a polyamide, and preferably nylon. This material is injection molded to form a resilient and sealing connection between members 54 and 55. The passage 55*a* in valve means 55 has a port 76 opening into chamber 70 and communicating at its rear end with the conduit 54*a* in armature member 54 and with conduit 51*c* in core member 51. Consequently, liquid fuel passes through inlet means 50, core member 51, armature member 54, needle valve means 55 and port 76 into chamber 70 from where it is discharged through discharge duct 65 when valve means 55 is retracted from the illustrated closing position in which it engages valve seat 68. A spring 75 in the core member 51 abuts against the rear end of the valve means 55 and against the inner shoulder 51*d* of member 51 to urge armature member 54 and needle valve means 55 into the closing position.

An annular nut 86 is screwed onto the threaded portion 85 of nozzle member 57 and has a flange 87 whose inner edge surrounds needle valve means 55. Nut 86, portion 85 and needle valve means 55 form a chamber 87*a* which is filled with fuel during the operation of the valve. Needle valve means 55 has an outer flange 84 located in chamber 87*a*. Flange 84 and flange 87 are spaced a selected distance so that the rearward, opening movement of needle valve means 55 is stopped by engagement of the flanges before the rear end of armature member 54 can engage the forward end of core member 51, which may cause the two members to adhere to each other due to magnetizing.

The above described embodiment of the present invention operates as follows: When transistor 28 supplies to winding 22 a magnetizing current, an electromagnetic field is produced, and attracts armature member 54 against the action of spring 75 so that the actuated armature member 54 moves toward the stationary core 51. The needle valve means 55 is fixedly connected by the resilient member 82 to the movable actuating member 54, and consequently valve member 55 is retracted from valve seat 68 so that the fuel, which is supplied under pressure by pump 38, passes through tubes 36, and the conduits formed by members 51, 54 and 55 into chamber 70 and from there through the discharge duct 65 and the outlet 63. The needle valve means 55 remains in open position, determined by flanges 84 and 87, until the impulse supplied by impulse generator 30 terminates. As soon as the impulse, which has a steep rear flank, ends and transistor 28 becomes non-conductive, the magnetizing current in the electromagnetic winding 22 terminates, and actuating armature 54 returns with needle valve means 55 under the action of spring 75 to the closing position of the needle valve means 55.

While the stroke of the armature and needle valve means is small, nevertheless there is a tendency of the needle to bounce back when engaging the valve seat which consists of hard steel. This is mainly due to the fact that the closing movement takes place at very high speed. Such bouncing back would cause an unintended opening of the discharge duct 65 and a second uncontrolled injection of fuel.

This undesirable effect is prevented by the resilient member 82 according to the present invention which elastically compensates the forces developed when needle valve means 55 is thrown against the valve seat, and bouncing back is prevented.

The hard impacts of the valve means 55 on the valve seat are further dampened by the liquid in chamber 87*a* which dampens the movements of flange 84, and thereby of needle valve means 55. Parts in the valve shown in FIG. 3 which correspond to parts described in detail with reference to FIG. 2, are indicated by the same reference numerals to which 100 is added. For example, the valve body means is indicated at 24 in FIG. 2, and at 124 in FIG. 3. However, the construction of FIG. 3 has several improvements as compared with the construction of FIG. 2.

In the valve illustrated in FIG. 2, the actuating armature member 54 is separated by a gap from the bore in the valve body means 24, and the movable member 54, 80, 55 is guided only by a cylindrical surface in portion 85 engaging needle valve means 55.

In the construction of FIG. 3, the movable armature member 154 is slidably guided in a tubular brass sleeve

140 which is mounted in valve body means 124. The needle valve means 155 is not guided, but passes through a bore 143 in an inward flange 142 of member 140. An annular throttling duct 190 is formed between flange 142 and portion 192 of needle valve means 155, and connects a space 170 in the valve body means 124 with a space 191 formed within member 140 by the armature member 154 and by a ring 152 adjacent the resilient thermoplastic member 180. The valve seat 168 is formed in a ring 144 which is clamped by member 156 against a sealing ring 162 and a shoulder in valve body means 124.

The operation of the valve means illustrated in FIG. 3 corresponds to the operation described with reference to the embodiment of FIG. 2. A rebound of valve means 155 is prevented by the resilient member 180 which is located between the actuating armature 154, and the needle valve means 155. Furthermore, liquid fuel in chambers 170 and 191 is displaced during movement of the needle valve means, and forced through the throttling duct 190 whereby the movement of the needle valve means 155 is dampened.

Since only actuating armature member 154 is guided, and needle valve means 155 is not guided, needle valve means 155 can perform a slight transverse movement due to the provision of the resilient member 180. In the event that needle valve means 155 is not exactly aligned with valve seat 168, the conical surface of needle valve means 155 will be slightly displaced upon engaging valve seat 168, and assume a position engaging the entire circumference of valve seat 168 to tightly close the discharge duct 165.

In the embodiment of FIG. 3, the inlet means 150 is threadedly connected to a member 200 with which fuel supply tube 36 is connected. A filter means 149 including a bag 195 consisting of filter material, and an attaching portion 196 is provided in the inlet conduit. Clamping members 147, 148 of a holding member 146 are secured to the filter bag. A resiliently deformable gas-filled container part 145 is tightly fitted into a groove of holding member 146. Part 145 is a bubble-like element consisting of thermoplastic material, which is compressed when the pressure in the inlet means 150 increases. Since elements 145 are provided in all inlet means of the valves 21 illustrated in FIG. 1, they serve as equalizing means for equalizing the pressure in the several valves, and prevent, together with pressure vessel 145, that pressure waves develop in the liquid fuel due to the fact that the fuel supply tubes 36 are of different lengths. The permeable filter means 149 also reduces such pressure waves since the liquid is forced through the filter. It is desirable to prevent pressure waves in the fuel, since such pressure waves may produce differences between the fuel amount injected by the several valves into the cylinders, although the opening and closing times are exactly the same in all valves.

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of valve arrangements differing from the types described above.

While the invention has been illustrated and described as embodied in a fuel injection valve having a valve needle means including a resilient portion, it is not intended to be limited to the details shown, since various modifications and structural changes may be made without departing in any way from the spirit of the present invention.

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, that from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed as new and desired to be secured by Letters Patent is:

1. Valve arrangement comprising, in combination, valve body means including a discharge portion formed with a discharge duct and chamber means including a chamber having a valve seat and communicating with said discharge duct, said valve body means including an inlet means for a liquid, and being spaced from said discharge duct; elongated needle valve means mounted in said valve body means for movement to and from a closing position engaging said valve seat for closing said discharge duct, said elongated needle valve means being formed with a longitudinal passage terminating in a port opening into said chamber means; a tubular actuating member movably mounted in said valve body means and having an inner conduit connecting said inlet means with said passage; a resilient block member having transverse projections connecting said tubular actuating member with said valve means for movement therewith; and operating means for reciprocating said actuating member to move said needle valve means to and from said closing position whereby the impact of said needle valve means on said valve seat is cushioned by said resilient block member.

2. Valve arrangement comprising, in combination, valve body means including a discharge portion formed with a discharge duct and chamber means including a chamber having a valve seat and communicating with said discharge duct, said valve body means including an inlet means for a liquid and being spaced from said discharge duct; elongated needle valve means mounted in said valve body means for movement to and from a closing position engaging said valve seat for closing said discharge duct, said elongated needle valve means being formed with a longitudinal passage terminating in a port opening into said chamber means; a tubular actuating member movably mounted in said valve body means, said actuating member consisting of magnetizable material and having an inner conduit connecting said inlet means with said passage; a resilient block member having transverse projections connecting said tubular actuating member with said valve means for movement therewith; and electromagnetic operating means fixedly secured to said valve body means and at least partly enveloping said actuating member for reciprocating said actuating member to move said needle valve means to and from said closing position whereby the impact of said needle valve means on said valve seat is cushioned by said resilient block member.

3. Valve arrangement comprising, in combination, valve body means including a discharge portion formed with a discharge duct and chamber means including a chamber having a valve seat and communicating with said discharge duct, said valve body means including an inlet means for a liquid and being spaced from said discharge duct; elongated needle valve means mounted in said valve body means for movement to and from a closing position engaging said valve seat for closing said discharge duct, said elongated needle valve means being formed with a longitudinal passage terminating in a port opening into said chamber means; a tubular actuating member movably mounted in said valve body means and having an inner conduit connecting said inlet means with said passage, said tubular actuating member having a portion surrounding a portion of said elongated valve means; a resilient block member located between said portions of said tubular actuating member and of said valve means fixedly connected to and in sealing engagement with the same, said resilient block member consisting of a thermoplastic synthetic material and having transverse projections connecting said tubular actuating member with said valve means for movement therewith; and operating means for reciprocating said actuating member to move said needle valve means to and from said closing position whereby the impact of said needle valve means

on said valve seat is cushioned by said resilient block member.

4. Valve arrangement comprising, in combination, valve body means including a discharge portion formed with a discharge duct and chamber means including a chamber having a valve seat and communicating with said discharge duct, said valve body means including an inlet means for a liquid and being spaced from said discharge duct; elongated needle valve means mounted in said valve body means for movement to and from a closing position engaging said valve seat for closing said discharge duct, said elongated needle valve means being formed with a longitudinal passage terminating in a port opening into said chamber means, said valve means having a portion located in said chamber means so that movement of said needle valve means is dampened by liquid in said chamber means; a tubular actuating member movably mounted in said valve body means, said actuating member consisting of magnetizable material and having an inner conduit connecting said inlet means with said passage; a resilient block member having transverse projections connecting said tubular actuating member with said valve means for movement therewith; and electromagnetic operating means fixedly secured to said valve body means and at least partly enveloping said actuating member for reciprocating said actuating member to move said needle valve means to and from said closing position whereby the impact of said needle valve means on said valve seat is cushioned by said resilient block member.

5. A valve arrangement as set forth in claim 4, wherein said valve body means is formed with a throttling duct opening into said chamber means so that liquid is forced through said throttling duct during movement of said valve means.

6. Fuel injection arrangement comprising, in combination, a plurality of fuel supply tubes for supplying liquid fuel; and a plurality of valves, each valve comprising a valve body means including an inlet means, said inlet means being respectively connnected to said fuel supply tubes, each valve body means having chamber means and including a discharge portion formed with a discharge duct and with a valve seat communicating with said discharge duct, each valve further comprising an equalizing means in said inlet means for equalizing pressure variations of liquid supplied by said fuel supply means into said inlet means; elongated needle valve means mounted in said valve body means for movement to and from a closing position engaging said valve seat for closing said discharge duct, said elongated needle valve means being formed with a longitudinal passage terminating in a port opening into said chamber means; a tubular actuating member movably mounted in said valve body means and having an inner conduit connecting said inlet means with said passage; a resilient block member having transverse projections connecting said tubular actuating member with said valve means for movement therewith; and operating means for reciprocating said actuating member to move said needle valve means to and from said closing position whereby the impact of said needle valve means on said valve seat is cushioned by said resilient block member.

7. Fuel injection arrangement comprising, in combination, a plurality of fuel supply tubes for supplying liquid fuel; a plurality of valves, each valve comprising a valve body means including an inlet means, said inlet means being respectively connected to said fuel supply tubes, each valve body means having chamber means and including a discharge portion formed with a discharge duct and with a valve seat communicating with said discharge duct, each valve further comprising a closed deformable container located in said inlet means, and gas in said container for equalizing pressure variations of liquid supplied by said fuel supply means into said inlet means; elongated needle valve means mounted in said valve body means for movement to and from a closing position engaging said valve seat for closing said discharge duct, said elongated needle valve means being formed with a longitudinal passage terminating in a port opening into said chamber means; a tubular actuating member movably mounted in said valve body means and having an inner conduit connecting said inlet means with said passage; a resilient block member having transverse projections connecting said tubular actuating member with said valve means for movement therewith; and operating means for reciprocating said actuating member to move said needle valve means to and from said closing position whereby the impact of said needle valve means on said valve seat is cushioned by said resilient block member.

8. A fuel injection arrangement as set forth in claim 7, and including filter means located in each of said inlet means of said valve body means.

9. An arrangement as set forth in claim 8, wherein said filter means includes a bag of filter material; wherein said fuel supply means open into the interior of each bag so that liquid fuel passes through said bags into the respective inlet means; wherein each filter means is secured to the respective valve body means; and wherein each deformable container is secured to the respective filter bag and supported by the same.

10. Fuel injection arrangement comprising, in combination, a plurality of fuel supply tubes for supplying liquid fuel; and a plurality of valves, each valve comprising a valve body means including an inlet means, said inlet means being respectively connected to said fuel supply tubes, each valve body means having chamber means and including a discharge portion formed with a discharge duct and with a valve seat communicating with said discharge duct, and a valve means movable to and from a position engaging said valve seat, each valve further comprising a deformable gas-filled and thereby resiliently compressible closed container located in said inlet means for equalizing pressure variations of liquid supplied by said fuel supply means into said inlet means.

11. A valve arrangement comprising, in combination, valve body means including a hollow main body portion having a bore, an inlet portion formed with an inlet bore communicating with and aligned with said bore of said hollow main body portion, and a discharge portion formed with a small chamber and with a discharge duct communicating with the interior of said main body portion and having a valve seat; electromagnetic winding means located in said interior of said hollow valve body portion and including a wall defining an inner space; an armature member partly located in said inner space and having a portion located in said bore of said main body portion and in said inlet bore and being slidably mounted in the same, said armature member having an inner passage communicating with said inlet bore, and an oblique surface located in said inlet bore; an adjusting screw means passing through said inlet portion with said inlet bore and engaging said oblique surface for adjusting the position of said armature member; spring means abutting said armature member and said valve body means for urging said armature member against said screw means; a movable actuating member located in said inner space and forming a gap with said armature member surrounded by said winding means, said gap being adjustable by adjustment of said armature member by said adjusting means, said actuating member having a passage connecting said passage with said chamber and discharge duct; and a valve member secured to said actuating member and being movable with the same to and from a closing position engaging said valve means for closing said discharge duct, said valve member having a passage communicating with said passages and a duct connecting said last-mentioned passage with said small chamber.

12. A valve arrangement as set forth in claim 11 wherein said armature member is slidably mounted in said bore of said main body portion and in said inlet bore so as to be removable from said valve body means through said

inlet bore when said adjusting screw means is retracted from said inlet bore.

13. A valve arrangement, comprising, in combination, valve body means including a hollow main body portion having a bore, an inlet portion formed with an inlet bore communicating with and aligned with said bore of said hollow main body portion, and a discharge portion formed with a small chamber and with a discharge duct communicating with the interior of said main body portion and having a valve seat; electromagnetic winding means located in said interior of said hollow valve body portion and including a wall defining an inner space; an armature member partly located in said inner space and having a portion located in said bore of said main body portion and in said inlet bore, said armature member having an inner passage communicating with said inlet bore; a movable actuating member located in said inner space and forming a gap with said armature member surrounded by said winding means, said actuating member having a passage connecting

said passage with said chamber and discharge duct; and a valve member secured to said actuating member and being movable with the same to and from a closing position engaging said valve means for closing said discharge duct, said valve member having a passage communicating with said passages and a duct connecting said last-mentioned passage with said small chamber.

References Cited in the file of this patent

UNITED STATES PATENTS

1,754,740	Clarkson	Apr. 15, 1930
2,633,150	Lewis	Mar. 31, 1953
2,767,737	Turak	Oct. 23, 1956

FOREIGN PATENTS

51,293	France (1st addition to No. 831,989)	Nov. 17, 1941
1,019,853	France	Nov. 5, 1952