United States Patent

Garnier

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[54] **ELECTROMAGNETIC INJECTORS**

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[30] **Foreign Application Priority Data**

Feb. 13, 1970 France.....7005124

[52] **U.S. Cl.** **239/585,** 239/533, 239/574

[51] **Int. Cl.** **B05b 1/32**

[58] **Field of Search** 239/585, 574, 533; 251/140, 251/141

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Attorney—Lloyd P. Shank and Clelle W. Upchurch

[57] **ABSTRACT**

An injector comprising a cylindrical casing, induction means and fuel-intake means, an injection nozzle body attached to said casing and enclosing an injection needle, a pallet adapted to be attracted at each injection cycle by said induction means for initiating the ejection of fuel, said pallet and said injection nozzle body cooperating to act as a valve for stopping and admitting fuel to said injection nozzle body.

9 Claims, 9 Drawing Figures

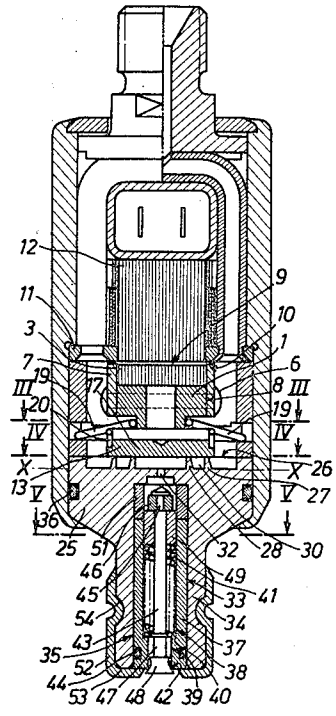


FIG. 1

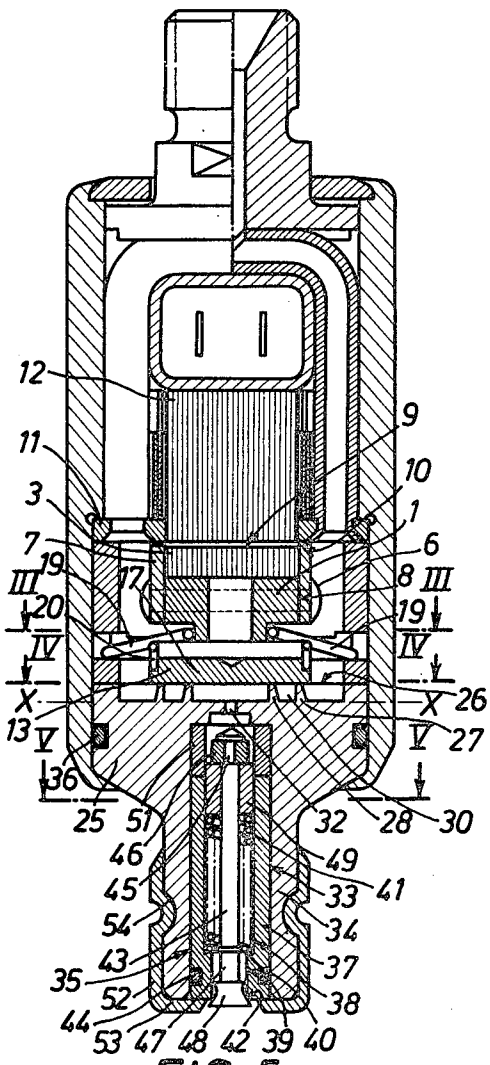


FIG. 2

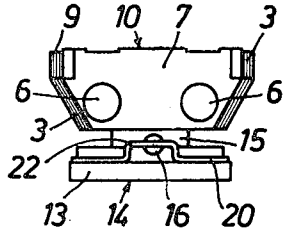


FIG. 3

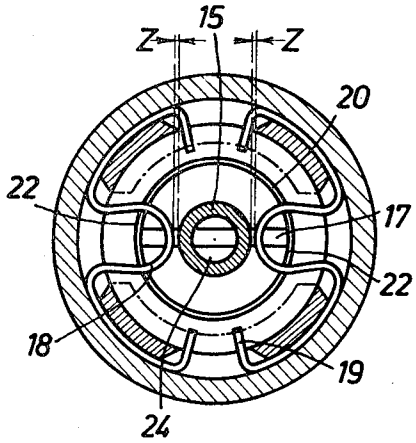


FIG. 4

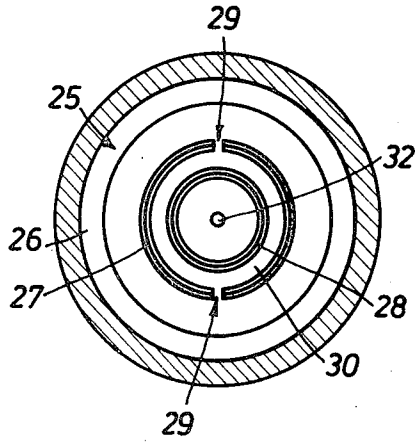


FIG. 5

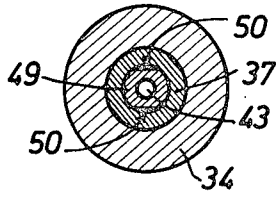


FIG. 6

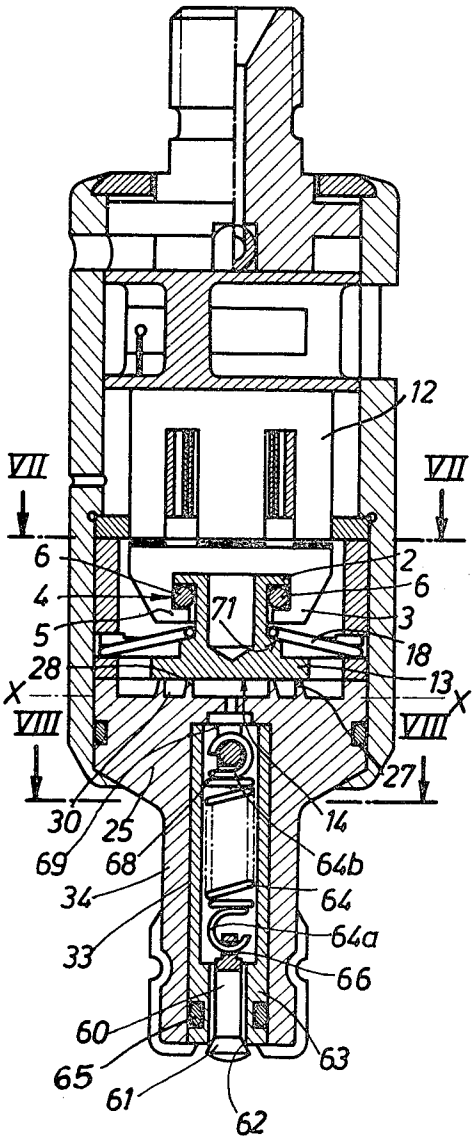


FIG. 7

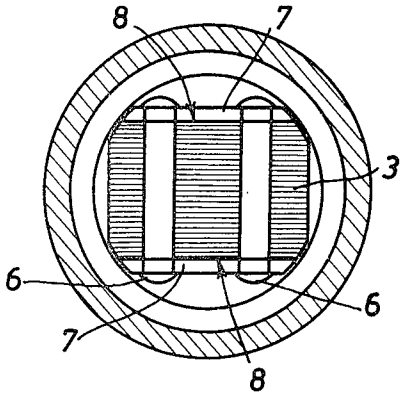


FIG. 8

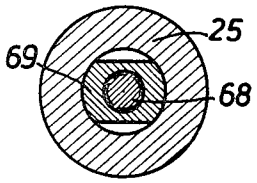
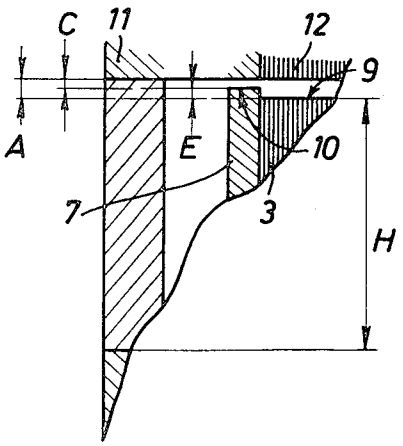


FIG. 9



ELECTROMAGNETIC INJECTORS

An electromagnetic injector having an extremely short operating time and therefore resulting in a very small displacement of the moving system has already been described in French Pat. application No. 69/31319 of Sept. 15, 1969.

In this design, the value of the air-gap between the inductor and the pallet accordingly becomes of considerable significance if the difference between a number of injectors must be as small as possible as is usually the case ; among other considerations, said value is a function of the parallel alignment of the planes which define the above-mentioned air-gap.

The form of construction which was contemplated in the above-cited patent application did not make it possible to obtain said parallel alignment automatically.

There are a number of basic reasons for this faulty parallelism and among these can be mentioned :

- imperfect perpendicularity of the pallet plane with respect to the axis of the injector pintle ;
- the play of said pintle within its bore ;
- imperfect perpendicularity of the pintle bore with respect to the plane of the top bearing surface of the injection nozzle, and so forth.

The aim of this invention is to overcome the disadvantages which arise from the defects outlined in the foregoing by virtue of a novel arrangement of the pallet and of the injector proper, the principal result of this arrangement being to achieve the requisite parallel alignment of the planes which define the air-gap.

The improved electromagnetic injector in accordance with the invention comprises a cylindrical body or casing together with all the induction means and fuel-intake means, an injection nozzle attached to said body and enclosing the injection pintle, an armature or pallet which is attracted at each injection cycle by the induction means for initiating the injection of fuel and is characterized in that the injection pintle and the pallet are not coupled together mechanically and that the admission of fuel to the injection pintle is carried out by the pallet which cooperates with the nozzle so as to form a valve.

In an advantageous embodiment, the novel electromagnetic injector can also have the following characteristic features :

- the pallet comprises a lamination-holder unit fitted with a disc which forms a flat valve and cooperates with at least one annular rib which forms a valve seat and which is provided on the top face of the injection nozzle.

The crest of the annular rib is located substantially in the plane of the nozzle bearing surface which is applied against one side of a spacer ring whilst the other side of said ring is parallel to the first and applied against an inductor support disc.

The annular rib which forms a valve seat is surrounded by a concentric rib which has at least one break in continuity for the flow of fuel and serves to support the moving system at the time of closure.

At the center of the annular rib which forms a valve seat, the nozzle comprises a calibrated metering duct and said duct opens into the bore which accommodates the injection pintle whose head forms a valve, said pintle being attached for the purpose of closing said valve to a calibrating spring which can be stressed either in compression or in tension.

The working surface of the flat valve of the lamination-holder unit and the pallet-lamination surface located opposite to the inductor are parallel to each other.

The top edges of the end-plates between which the pallet laminations are clamped are located in a plane which is parallel to the top plane of said laminations.

Two forms of construction of an improved electromagnetic injector in accordance with the invention are shown diagrammatically and by way of example in the accompanying drawings. The arrangement of the upper portion of the injector up to the level of the plane X—X is the same in both forms of construction and is in any case already described in French Pat. application No. 69/31319 as filled by the present Applicant.

In the drawings :

FIG. 1 is a longitudinal axial sectional view of a first form of construction of the injector ;

FIG. 2 is a profile view of the moving system which will be referred-to hereinafter as the "pallet";

FIGS. 3, 4 and 5 are transverse sectional views taken respectively along the lines III—III, IV—IV and V—V of FIG. 1 ;

FIG. 6 is a view which is similar to that of FIG. 1 and shows a second form of construction of the injector which differs from the previous embodiment only in the lower portion of the figure which is located beneath the plane X—X ;

FIGS. 7 and 8 are transverse sectional views taken respectively along the lines VII—VII and VIII—VIII of FIG. 6 ;

FIG. 9 is a diagrammatic sectional view on a larger scale which is intended to show on the one hand the air-gap formed between the fixed inductive magnetic circuit and the induced magnetic circuit of the moving system and on the other hand the range of travel of said moving system.

In the exemplified embodiment of FIGS. 1 to 5 and of the top portion (namely above the plane X—X) of FIG. 6, the fixed inductor, the terminals of the inductive circuit and the fuel-supply means have the same arrangement as that which has already been described in detail in the above-mentioned patent application.

The pallet or moving system (shown in FIGS. 1, 2 and 6) comprises a lamination holder or support bracket 1, the top portion of which forms a a rectangular flange 2 on which are fitted the armature laminations 3. These laminations are provided on each side of the plane of symmetry with a recess 4 which terminates in a bottom retaining heel 5 so that the complete assembly forms a cavity in which the flange 2 is engaged. Said flange is secured in position by means of two rivets 6 which are located within the space formed between the underface of the flange 2 and the top face of the heels 5 ; said rivets serve to compress the laminations 3 by means of two end-plates 7 which are formed of non-magnetic material.

As shown more particularly in the diagram of FIG. 9, the end-plates 7 project beyond the top face 9 of the laminations 3 to a distance E corresponding to the air-gap when the pallet is attracted to the end of travel by the energized inductor. In this position the top faces 10 of the end-plates 7 are in contact with the disc 11 which clamps the magnetic laminations 12 of the inductor.

The bottom portion 13 of the pallet body 1 which supports the laminations 3 is designed in the form of a disc, the flat underface 14 of which is ground with a high degree of precision in order to be parallel to the face 9 of said laminations and the disc 13 aforesaid thus constitutes a valve.

The intermediate portion 15 of the pallet body 1 is pierced by a transverse bore 16 in which is fitted a locking-pin 17 and the loops 18 of two restoring springs 19 are oriented in the centripetal direction and applied against the two extremities of said locking-pin which project from said body.

The extremities of the locking-pin 17 are imprisoned and said locking-pin is accordingly secured in position by a wire ring 20 (formed of piano wire, for example) which is engaged in a groove formed in the periphery of the disc 13. Said wire ring 20 has two diagrammatically opposite and upwardly oriented loops 22 which are engaged between the lateral arms of the loops 18 of the springs 19. The loops 22 of the ring 20 are intended on the one hand to limit the axial displacement of the locking-pin 17 and on the other hand to ensure the orientation of the pallet with respect to the stationary portion of the injector.

The transverse displacement of the pallet is limited by the clearance Z which is provided between the extremities of the loops 18 of the springs 19 and the corresponding opposite zones of the intermediate portion 15 of the pallet body 1 which is made lighter in weight by means of an axial bore 24.

The injector nozzle 25 is provided at the top portion thereof with an annular bearing surface 26 and two concentric ribs 27 and 28, the summits of which are located in the same plane as the bearing surface aforesaid.

The outer rib 27 serves to support the face 14 of the moving system when this latter is moved away from the inductor 12 by the restoring springs 19 and has two breaks in continuity 29 which permits propagation of the fuel supply pressure within the annular chamber 30 which is located between the ribs 27 and 28.

The crest of the inner rib 28 is flat and ensures leak-tight closure when said rib is in contact with the flat face 14 of the valve 13 of the moving system.

A calibrated fuel-metering aperture 32 is located in the axis of the injector nozzle 25, extends from the top face of said nozzle and opens into a bore 33 which is formed in the extension 34 of the nozzle. Said bore serves as a housing for a calibrated valve unit which is generally designated by the reference numeral 35. A peripheral groove is formed on the periphery of the injector nozzle in order to accommodate a seal 36.

The calibrated valve unit 35 comprises a sleeve or cylindrical body 37 having two bores 38 and 39 of different diameter, said bores being separated by an annular bearing surface or shoulder 40 which serves to support one extremity of a helical restoring spring 41. The bottom portion or outlet of the bore 39 terminates in a conical seat 42 which is intended to cooperate with the head 48 of the pintle 43 of the calibrated valve unit 35. In the bottom portion of the cylindrical body 37, there is formed an annular groove for accommodating a seal 44 which ensures leak-tightness with the bore 33.

The pintle 43 consists of a cylindrical rod and is provided at the top with a groove 45 in which is fitted a retaining ring 46.

The lower end of said pintle has an enlarged cylindrical portion which slides within the bore 39 and on which are formed flat surfaces 47 for the flow of fuel. The top portion of the pintle is also guided by a piston 49 which slides within the upper bore 38 of the cylindrical body 37. As shown in FIG. 5, said piston is provided with flat surfaces 50 for the flow of fuel and serves as a support for the upper extremity of the restoring spring 41.

Axial locking of the cylindrical body 37 within the bore 33 is ensured on the one hand by means of a spacer ring 51 and on the other hand by means of the inwardly bent extremity 53 of a sleeve 52 which is fitted over the extension 34 of the injection nozzle 25 and the side wall of which is swaged at 54 or deformed into a circular groove of the aforesaid extension 34.

All the elements which have already been described in the previous embodiment are again shown in the alternative embodiment of FIGS. 6 and 8 in that portion which is located above the plane X—X.

The only difference lies in a particular arrangement of the calibrated valve unit which is located within the bore 33 of the injector nozzle 25–34. Said valve unit which is designated by the reference numeral 60 in FIG. 6 terminates at the lower end in a conical head 61 which cooperates with a valve seat 62 formed in a cylindrical body 63 which is fitted within the bore 33.

An annular groove formed in the body 63 serves to accommodate a seal 65.

A restoring spring 64 has an extremity 64*a* which is engaged in a hole 66 of the valve 60 ; the other extremity 64*b* of said spring is attached to a pin 68 which is engaged in grooves 69 of the cylindrical body 63.

In the form of construction shown in FIGS. 6 and 8, there is also shown another possible design solution for supporting the loops 18 of the restoring springs 19 on the pallet body 1. In this alternative form, the said body has two inclined planes 71 which form said support.

The return spring (41 or 64) is calibrated so that the pressure to exert within bore 33, i.e., downstream of the calibrated aperture 32 is less than the fuel feed pressure upstream of the aperture 32. When the pallet is attracted by the coil induction means and uncovers the rib 28, this fuel feed pressure is wholly applied to said aperture. Indeed, rib 28 has a sufficient diameter so that the distance between its upper edge and the plane face of the pallet facing it forms a sufficient passage section to avoid loss of pressure. The flow of fuel through the calibrated aperture 32 during the time of opening of the pallet, opens the calibrated valve 35, the pressure upstream of the aperture being the feed pressure and the pressure downstream of the aperture being determined by the calibration of the return spring. The displacement of needle 47 (or of valve member 60) permits the passage out of the injector of the fuel which has flowed through the aperture 32.

As soon as the pallet ceases to be attracted, it is applied onto rib 28 by the return springs and arrival of fuel to aperture 32 is interrupted.

Needle 47 (or valve member 60) is therefore applied onto its seat by its return spring. Needle 47 (or valve member) is thus controlled only by the flow of fuel through metering aperture 32.

What I claim is:

1. A fuel injector for internal combustion engines of the type comprising a cylindrical casing, fuel feed means, coil induction means, an injection nozzle enclosing an injection needle-valve, a pallet attracted at each injection cycle by said coil induction means and located in said casing for controlling the injection, wherein a fuel metering calibrated aperture is formed in the upper face of the injection nozzle facing a plane face of the pallet constituting a plane closure member, the injection needle-valve having a head at its end opposed to the calibrated aperture cooperative with a seat which puts the injection nozzle in communication with the exterior of the injector, said needle-valve being biased in contact with said seat by a calibrated spring for controlling the fuel pressure downstream of the metering aperture which pressure is substantially lower than the fuel feed pressure.

2. A fuel injector as claimed in claim 1, wherein the metering aperture is surrounded by a continuous rib, which is coaxial with said aperture and spaced from the edge of the aperture.

3. A fuel injector as claimed in claim 2, wherein said continuous rib is surrounded by a concentric rib having a larger diameter and the same height, said concentric rib having at least one gap for the passage of the fuel.

4. A fuel injector for internal combustion engines comprising a casing, an injector nozzle having a substantially closed end disposed in the casing and an opposite external end, a bore in the injection nozzle open at said external end and terminating short of the closed end of the nozzle, fuel feed means through the casing, an aperture through said closed end connecting said bore and said fuel means, a pallet having a face adapted to combine with said closed end to block fuel flow through the aperture, means for biasing the pallet into blocking relationship with the closed end, an induction coil in said casing adapted to attract and move the pallet against the biasing action from said blocking relationship, piston means slideable in said bore carrying means for closing the said open end of the bore, means for biasing said piston into closing relationship with the said open end when the aperture is closed by the pallet but responsive to said fluid pressure to move from its closing position when the pallet is biased away from the aperture.

5. The fuel injector of claim 4 wherein the said piston means is an elongated pin having a substantially conical end adjacent said aperture and an outwardly flared opposite end adapted to close the open end of the bore.

6. The fuel injector of claim 4 wherein a valve is disposed in said bore having a sleeve disposed snugly therein, a first bore in the sleeve communicating with the aperture, a counter-bore of greater cross-section communicating between the said first bore and the external end of the nozzle, a pin slideable in the first bore and counter-bore, a conical end carried by the pin adjacent to said aperture and means carried by the pin at its opposite end for closing the bore in the sleeve adjacent to the external end of the nozzle, and a spring biasing said opposite end of the pin into closing relationship with the said bore.

7. The fuel injector of claim 6 wherein the pin carries a piston adjacent its conical end and said spring is compressed between the piston and a shoulder formed by the bore and counter-bore of the sleeve.

8. The fuel injector of claim 6 wherein a first valve member is slideably disposed in the counter-bore, a second valve member is adjacent to said aperture, and a biasing spring is attached at its opposite ends to the valve members.

9. The injector of claim 4 wherein the surface of the said closed end carries a ring about the aperture and the said face of the pallet is disposed on the ring when the pallet is not attracted by the induction coil.

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