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[54] FUEL FEED DEVICES FOR INTERNAL COMBUSTION ENGINES

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[51] **Int. Cl.**.....**F02d 5/00**

[58] **Field of Search** .....123/32 AE, 32 EA, 119, 139.17, 123/139.18, 139 AW; 239/131, 318, 366, 368, 369, 585

[56] **References Cited**

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[57] **ABSTRACT**

Liquid fuel is injected under pressure into the induction pipe downstream of the main throttle valve. The fuel flow is metered to the injection orifice by a valve actuated by an electromagnet according to the airflow in the induction pipe. The injection orifice is aligned with an auxiliary orifice in an air chamber at constant pressure. The airflow to the chamber is carried close to the electromagnet so as to cool it.

6 Claims, 2 Drawing Figures

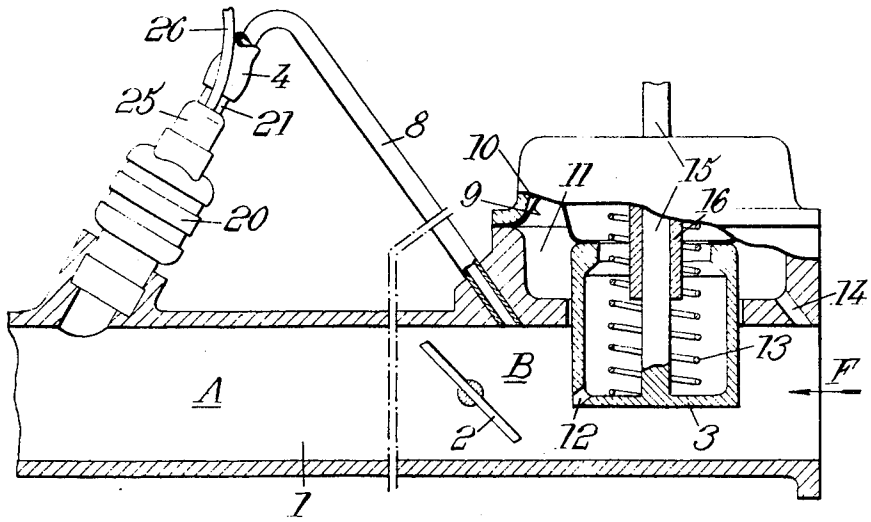
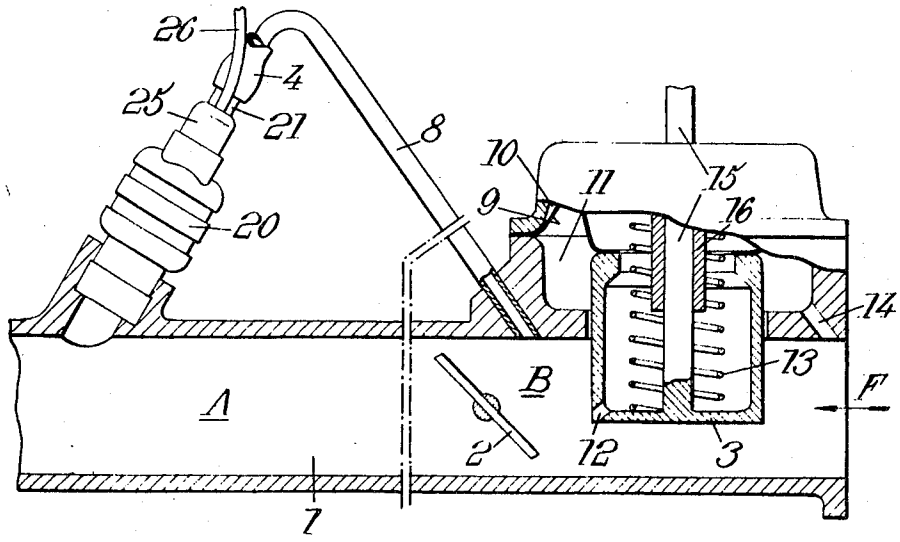


Fig. 1.



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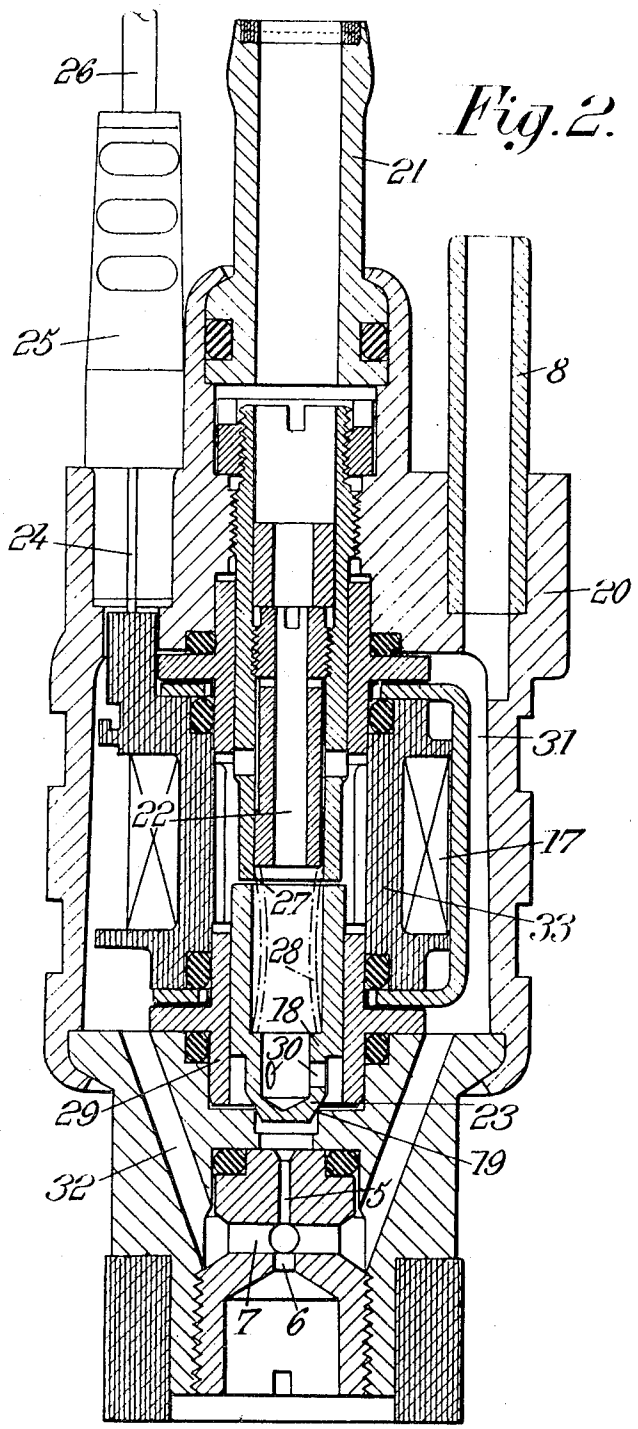

Fig. 2.

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FUEL FEED DEVICES FOR INTERNAL COMBUSTION ENGINES

The invention relates to injection devices, for internal combustion engines, which comprise, on the one hand, a source of liquid fuel under pressure connected to an injection orifice communicating with a zone of the induction pipe situated downstream of said pipe and, on the other hand, a metering system adapted, by acting on the energization of an electromagnet which actuates a valve cooperating with the injection orifice, to modify the flow of fuel injected according to the flow of air passing in said pipe, the aforesaid injection orifice being aligned with an auxiliary orifice which opens into the aforesaid zone of the induction pipe and the space included between the two orifices belonging to a chamber aerated at a substantially constant pressure.

Such a device is described particularly in U.S. Pat. No. 3,543,739 of applicant.

It is to render the fuel flow independent of the pressure, (or at least of variations in pressure) existing in the zone concerned of the induction pipe that the injection orifice does not open directly into this zone but into a chamber aerated at a substantially constant pressure. This aeration can be done either directly from the atmosphere, or in the general air inlet of the injection device, immediately downstream of an air filter, or again, according to the disclosure of the U.S. Pat. application No. 12,700 filed by applicant on the same day as the present application, in a portion of the induction pipe bounded by the aforesaid main throttle member and by an auxiliary throttle member arranged to open automatically and progressively in proportion as the flow of air in the said pipe increases. In the latter case, these aerating conditions are always present for slight airflows but the aeration can be effected with the portion of the induction pipe situated upstream of the auxiliary throttle member when the airflow increases beyond a predetermined value.

Given that the pressure established in the said chamber is constantly greater than that which exists in the said zone of the induction pipe, there is produced between them an air circulation during the operation of the engine.

It is an object of the invention to protect the electromagnet actuating the injection valve against excessive heating.

Accordingly, the above-defined injection device is characterized in that the circuit leading air to the aforesaid chamber passes close to the electromagnet, so that air displaced in said conduit towards the aforesaid zone of the induction pipe contributes to the cooling of the electromagnet.

The invention will be in any case, more fully understandable with the aid of the rest of the description which follows, which describes a preferred embodiment according to the invention, given purely by way of illustrative but nonlimiting example, with reference to the accompanying drawings, in which:

FIG. 1, shows, partly in elevation and partly in axial cross section, one embodiment of an injection device according to the invention; and

FIG. 2 shows, on a larger scale and in cross section, the essential elements of the embodiment shown in FIG. 1.

As regards the injection device as a whole, it is advantageously constructed according to the disclosure of the first above-mentioned patent application by including in it:

- on the one hand, in its induction pipe **1**, upstream of a main throttle member (or butterfly valve) **2** actuated by the driver, an auxiliary throttle member **3** which is opened automatically and progressively in proportion as the airflow in the pipe **1** increases (the direction of flow being shown diagrammatically by the arrow F),
- on the other hand, a source of liquid fuel under pressure (not shown) connected, by a pipe **4**, to an injection orifice **5** communicating with a zone A of the pipe **1** situated downstream of the main throttle member **2**,
- and finally, a metering system (not shown) sensitive to the position of the auxiliary throttle member and adapted to regulate the flow of fuel to be injected through the orifice **5** in such manner that the richness of the air-fuel mixture is substantially constant, at least for certain operating conditions of the engine.

In addition, the injection orifice **5** is aligned with an auxiliary orifice **6** which opens into the zone A of the pipe **1**, the space included between the two orifices **5** and **6** belonging to an aerating chamber **7** where the pressure is independent of that existing in the zone A, so that the flow of fuel through the orifice **5** is itself rendered independent of this latter pressure or of its variations. The section of the orifice **6** is preferably greater than that of the orifice **5**. The chamber **7** is connected to the atmosphere in the manner specified below by means of a tube **8** of which the cross section is distinctly greater than that of orifice **6**.

In the embodiment shown in the drawings, the auxiliary throttle member **3** is constituted by a plug capable of being transversely displaced with respect to the pipe **1** to be able to more or less close it. This plug is actuated by a pneumatic device comprising a diaphragm **9** separating two chambers **10** and **11** from one another. An orifice **12**, passing through the wall of the plug **3**, places the chamber **10** in communication with the section B of the pipe **1** which is included between the throttle members **2** and **3**. A spring **13** tends to push back the plug inside the pipe **1** against the action of the reduced pressure which is transmitted into chamber **10** through the orifice **12**. Chamber **11** is placed at atmospheric pressure through a passage **14** which opens, preferably into the inlet of pipe **1** between an air filter (not shown) and the plug **3**. Finally, the latter bears a central shank **15** which slides in a guide **16** and projects outside to act on the said metering system.

It is known that the position taken at each moment by the plug **3** and its shank **15** corresponds to the flow of air which circulates in the pipe **1** in the direction of the arrow F. The greater this flow, the more the shank **15** lifts, a substantially constant reduced pressure being established in the section B of the pipe **1**.

It is clear that the plug **3** could be replaced by any one of the equivalent auxiliary throttle members well known to those skilled in the art.

As regards the aforesaid metering system, it is advantageously made to include a member (not shown) driven in continuous rotary movement and capable, by acting on the energization of an electromagnet **17** which actuates a valve **18** cooperating with a seat **19** situated upstream of the injection orifice **5**, to determine, over a fraction only of each of its turns, the opening of this valve, and the system is arranged in such manner that it increases the said fraction in proportion as the opening of the auxiliary throttle member **3** increases (that is to say in the example shown, the lifting of the shank **15**) and vice versa. Various solutions to constitute this metering system have been described in the first patent mentioned above as well as in the U.S. Pat. application Ser. No. 10,420 filed by applicant on Feb. 11, 1970.

Whatever the construction of this metering system, it adapts the fuel flow to the airflow which passes in the pipe **1** from one side to the other of the auxiliary throttle member **3**.

The tube **8** may be connected either, as shown in FIG. 1, to the section B of pipe **1**, at least for the positions of the throttle member **3** corresponding to slight airflows, or to the air inlet of this pipe (that is to say upstream of the throttle member **3**), or again directly to the atmosphere.

This being the case, according to the invention the circuit leading the air to the aeration chamber **7** passes close to the electromagnet **17**, so that the air displaced in this circuit towards the zone A of the induction pipe **1** contributes to the cooling of the electromagnet.

In the embodiment shown in the drawings, the injection device comprises a main injector body **20** which receives, at one of its ends, a ferrule on which the pipe **4** is fitted. The ferrule **21** is extended by an inner passage **22** which ends at the valve **18**. The latter possesses externally a cylindrical guide surface adapted to slide in contact with an axial tubular guide **29** and it is internally hollow, at least one orifice **30** passing through the wall of the valve to enable the fuel coming from the passage **22** to pass from the inside to the outside of the valve. The latter comprises, at its downstream end, a conical surface **23** which cooperates with the seat **19**.

The electromagnet **17** is of annular shape and it surrounds the passage **22** at least in part and the valve **18**. Its winding is supplied with electric current through the male contacts **24** on which are engaged female contacts (not shown) borne by a connector **25** of plastics material extended by a lead **26**. This latter ends at an intermittent source of electric current belonging to the above-said metering system. The supply of the electromagnet **17** has the effect of raising the valve **18** until it comes into contact with a stop **27**. When the magnetic field is interrupted as a result of cutting off the current, a spring **28**, denoted by mixed line pushes back the valve **18** on the seat **19**, thus interrupting the fuel flow which had been established on the energizing of the electromagnet.

The electromagnet **17** has an outer diameter smaller than the inner diameter of the portion of the body **20** which contains it, so that there exists, around the electromagnet, an annular space **31**.

According to the invention, the tube **8** bringing the aerating air opens into this space **31** which is connected to the aerating chamber **7** by at least one passage **32** passing through the front portion of the body **20**. The above-said circuit bringing air to this chamber is hence constituted by the tube **8**, the space **31** and one or more passages **32**.

There is thus obtained an injection device whose operation and advantages are as follows.

It is known that, since zone A of the induction pipe **1** is subject to more or less intense reduced pressure during the operation of the engine, air circulates constantly in the same direction from the tube **8** towards chamber **7** to penetrate into zone A through the orifice **6**. This results in continuous renewal of the air inside the space **31** where the winding of the electromagnet **17** is located. In this way, heat released by this winding is removed by the air which circulates in the body **20** and which thus contributes to its cooling.

This effect is very useful since, if the fuel which circulates in the central portion (passage **22** and interior of valve **18**) also takes part in the cooling, the winding remains separated from the liquid by a large insulating mass constituted by its support **33**. Moreover, the injector can happen to be in a very hot atmosphere since the assembly is generally placed under the hood of the engine and close to the cylinder head of the latter, or even close to its exhaust pipe. The heating by external radiation is hence not negligible in certain cases and adds to the heating of the winding produced by the Joule effect on the passage of the current. The addition of these two phenomena could lead to deterioration of the insulation of the winding and in particular of its support **33**, which is generally constituted by a plastics material.

The air current established according to the invention has hence the effect, on the one hand, of avoiding transmission of heat between the body of the injector **20** and the winding of the electromagnet **17**, and, on the other hand, of removing calories released through this winding and this in continuous and permanent manner.

The invention therefore prevents excessive heating of the electromagnetic valve. It enables, through this fact, the use, if this is necessary, of much greater intensities in the said winding and it avoids imposing the arrangement of insulating means outside the apparatus to overcome the disadvantages due to heating by radiation from the exterior.

As is self-evident, and as results besides already from that which precedes, the invention is in no way limited to that of its embodiments, nor to those of its methods of using its various parts, which have been more particularly envisaged; it embraces, on the contrary, all variations.

What I claim is:

1. In an injection device, for internal combustion engines, comprising a source of liquid fuel under pressure connected to an injection orifice communicating with a zone of the induction pipe situated downstream of the main throttle member of said pipe and a metering system adapted, by acting on the energization of an electromagnet which actuates a valve cooperating with said injection orifice, to modify the flow of injected fuel according to the airflow passing in said pipe, said injection orifice being aligned with an auxiliary orifice which opens into said zone of the induction pipe and the space included between the two orifices forming a chamber aerated at a substantially constant pressure, the improvement comprising air circuit means bringing the air to said chamber and defining a space around and close to the electromagnet, so that the airflow in said air circuit towards said zone of the induction pipe contributes towards the cooling of the electromagnet.

2. An injection device according to claim **1**, wherein said electromagnet, which is of annular shape, is traversed axially by the fuel passage and is arranged with radial play inside an injector body, wherein said air circuit means defines an annular space left free around the electromagnet to form part of said air circuit.

3. An injection device according to claim **1**, wherein said metering system comprises a member driven in continuous rotary movement and capable, by acting on the energization of the electromagnet, of determining, over a fraction only of each of its turns, the opening of said valve, said system being arranged in such fashion that it increases said fraction in proportion as the opening increases of an auxiliary throttle member arranged in said induction pipe upstream of said main throttle member and adapted to be opened automatically and progressively in proportion as the airflow in said induction pipe increases.

4. An injection device according to claim **2**, wherein said metering system comprises a member driven in continuous rotary movement and capable, by acting on the energization of the electromagnet, of determining, over a fraction only of each of its turns, the opening of said valve, said system being arranged in such fashion that it increases said fraction in proportion as the opening increases of an auxiliary throttle member arranged in said induction pipe upstream of said main throttle member and adapted to be opened automatically and progressively in proportion as the airflow in said induction pipe increases.

5. An injection device according to claim **3**, wherein said air circuit means, upstream of it, is connected to the zone of the induction pipe situated between the main throttle member and the auxiliary throttle member, at least for positions of said auxiliary throttle member corresponding to slight airflows.

6. An injection device according to claim **4**, wherein said air circuit means, upstream of it, is connected to the zone of the induction pipe situated between the main throttle member and the auxiliary throttle member, at least for positions of said auxiliary throttle member corresponding to slight airflows.

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