United States Patent

Arnaud

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[54] **FUEL FEED DEVICES FOR INTERNAL ENGINES**

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[51] **Int. Cl.**.....**F02m 51/02**

[58] **Field of Search**...123/119 R, 139 AW; 261/50 A

[56] **References Cited**

UNITED STATES PATENTS

3,543,739	12/1970	Mennesson	123/119
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[57] **ABSTRACT**

In the intake pipe upstream of the main throttle is an auxiliary throttle which opens automatically and proportionately to the air flow. Liquid fuel is injected downstream of the main throttle. A metering system sensitive to the auxiliary throttle at least for certain operational conditions keeps the air/fuel mixture constant, the fuel injection is controlled by an electromagnetic valve. The metering system consists of a rotating member controlling the current to the electromagnet so as to open the injector over only a fraction of each turn, this fraction varying directly as the opening of the auxiliary throttle. A pressure regulator on the delivery pipe of the fuel pump has a discharge valve which opens under the effect of the delivery pressure and closes under the effect of suction in the intake pipe between the two throttles. The discharge valve is coupled to a diaphragm to which the suction is transmitted by a linking channel, which has a choke to ensure smaller flow from the intake pipe to the diaphragm than in the reverse direction.

2 Claims, 2 Drawing Figures

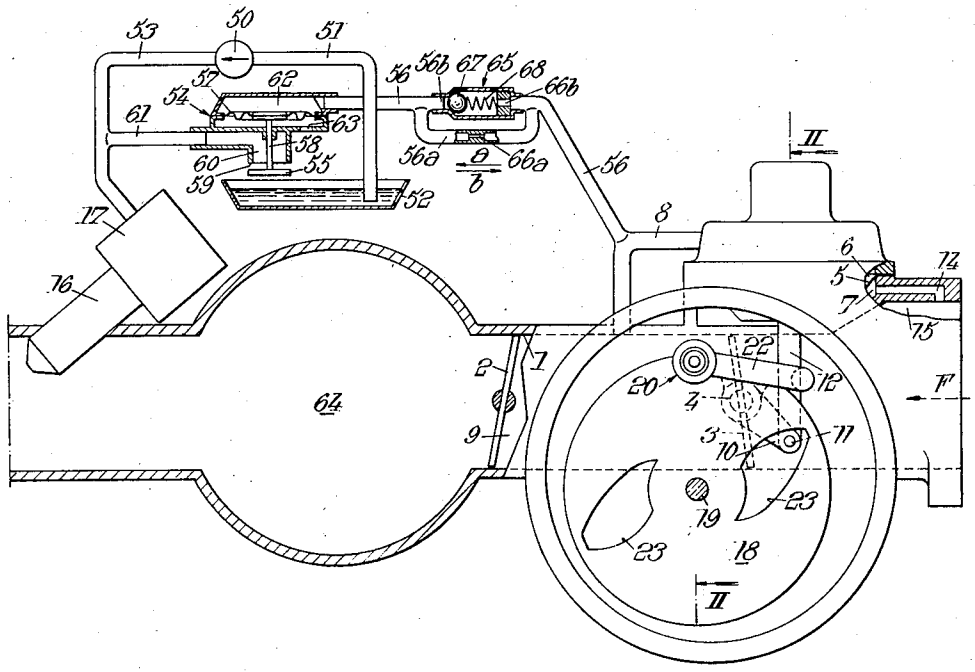

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Fig. 1.

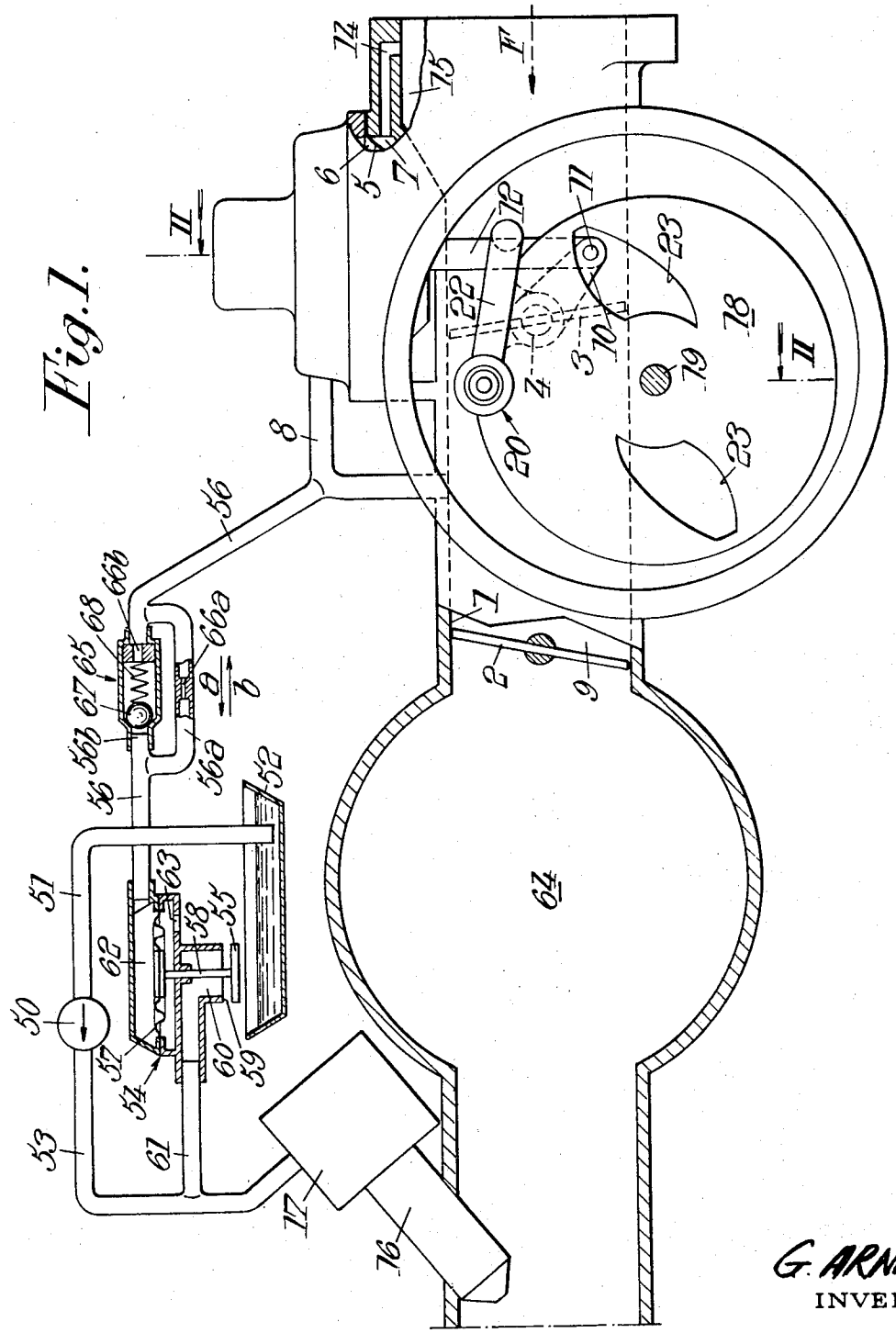

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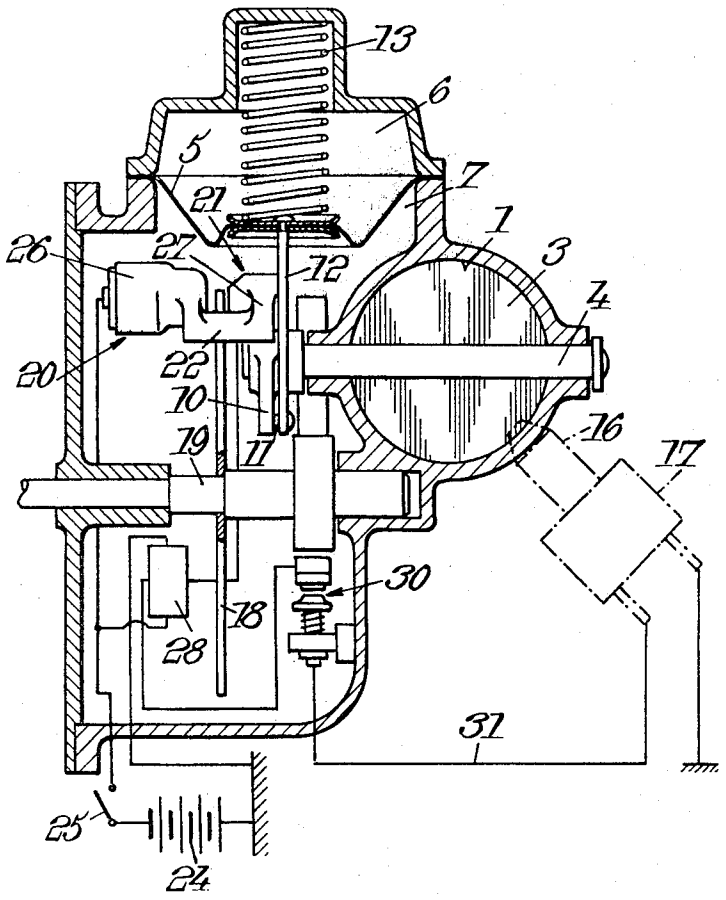
Fig. 2.



FUEL FEED DEVICES FOR INTERNAL ENGINES

The invention relates to fuel feed devices, for internal combustion engines, of the type of those which comprise, on one hand, in their intake pipe, upstream of a principal throttle member actuated by the driver, an auxiliary throttle member which opens automatically and progressively in proportion as the flow of air in the said pipe increases, on the other hand, means for injecting under pressure liquid fuel into that portion of this pipe situated downstream of the main throttle member and, on the other hand lastly, a metering system sensitive to the position of the auxiliary throttle member and adapted to regulate the flow of injected fuel in such a way that the richness of the air/fuel mixture passing into the intake pipe is substantially constant, at least for certain conditions of operation of the engine, the abovesaid injection means being constituted by a source of fuel under pressure of which the delivery circuit opening into the above-said portion of the intake pipe is controlled by at least one valve actuated by an electromagnet.

The invention relates more particularly to those devices of the type concerned which have been described in U.S. Pat. No. 3,543,739 of Oct. 9, 1968 to Andre Louis Mennesson and of which the abovesaid metering system comprises a member driven in continuous rotation and capable, by acting on the energization of the electromagnet, of determining over a fraction only of each of its revolutions the opening of the valve, this system being arranged so that it increases or decreases the said fraction in proportion as the opening of the auxiliary throttle member increases or decreases respectively.

The invention relates more particularly again to those devices of the type concerned of which the source of fuel under pressure is constituted by a fuel pump on the delivery pipe of which acts a pressure regulator which comprises a discharge valve tending to open under the effect of the delivery pressure of the pump and to close under the effect of the suction existing in the zone of the intake pipe comprised between its two throttle members, which suction is transmitted through a linking channel on to a diaphragm to which the discharge valve is coupled.

Of course the position of the auxiliary throttle member is characteristic of the flow of air passing from upstream to downstream of this member. If the volume of the portion of the intake pipe comprised between the intake valves of the internal combustion engine and the main throttle member is considerable with respect to the stroke volume of the engine, the flow of air measured by the auxiliary throttle member is not strictly equal, at transient speeds (acceleration or deceleration), to that which is in fact absorbed by the engine at the same moment.

For example, on brisk deceleration, the flow of air measured by the auxiliary throttle member drops rapidly through the closing of the main throttle member. On the other hand, until the establishment of a new constant speed, the engine absorbs a certain quantity of air which corresponds to the dropping pressure in the intake pipe and which is hence not measured by the auxiliary throttle member. As a result, until the establishment of the constant speed, the engine receives an air/fuel mixture which is too poor, the operation of the engine then no longer being satisfactory.

In order to overcome this drawback, the feed device of the type defined above is characterized by the fact that on the abovesaid linking channel are arranged throttle means ensuring a smaller flow cross-section in the sense going from the abovesaid zone of the intake pipe to the diaphragm of the pressure regulator than in the reverse direction.

Due to this construction, the speeds of variations of the suction transmitted to this diaphragm are adjusted in such a way that, even on accelerations and decelerations, the richness of the air/fuel mixture is maintained substantially constant.

In order that the invention may be more fully understood, a preferred embodiment of a carburetter according to the invention is described below purely by way of illustrative and non-limiting example, with reference to the accompanying drawings in which:

FIG. 1 shows in diagrammatic elevation with portions in cross-section one embodiment of a fuel feed device constructed according to the invention; and

FIG. 2 shows a section of the embodiment of FIG. 1 along the line II—II.

According to the invention, and more particularly according to that of its methods of application, as well as according to those of its methods of production of its various parts, to which it would appear that preference should be given, in order to construct a fuel feed device for vehicle engines or the like, procedure is as follows.

As regards the device as a whole, it is constituted in any suitable manner such that it comprises:

on one hand, in its intake pipe **1**, upstream of a main throttle member **2** actuated by the driver, an auxiliary throttle member **3** which opens automatically and progressively in proportion as the flow of air in the pipe **1** increases, the direction of flow being indicated by the arrow F in FIG. 1;

on the other hand, means for injecting liquid fuel under pressure into the portion of the pipe **1** situated downstream of the main throttle member **2**;

on the other hand lastly, a metering system sensitive to the position of the auxiliary throttle member **3** and adapted to regulate the flow of fuel injected in such a way that the richness of the air/fuel mixture passing into the pipe **1** is substantially constant, at least for certain conditions of operation of the engine.

In the embodiment shown, the auxiliary throttle member **3** is constituted by a butterfly valve keyed on an axle **4**. This valve is actuated by a pneumatic device comprising a diaphragm **5** separating two chambers **6** and **7** from one another. The chamber **6** is connected by a channel **8** to a chamber **9** constituted by the zone of the pipe **1** which is comprised between the main throttle member **2** and the valve **3**. The axle **4** is rigidly fixed to a lever **10**, provided at its free end, with a pin **11** which cooperates with the end of a rod **12**, which is connected to the diaphragm **5**. A spring **13** tends constantly to close the valve **3** against the action of the suction transmitted into the chamber **6**. The chamber **7** is placed at atmospheric pressure through a channel **14** starting preferably from the air intake **15** of the pipe **1**.

Of course the angular position taken up at any moment inside the pipe **1** by the valve **3** corresponds to the flow of air which flow in this pipe. The greater the

delivery of air, the more the valve 3 opens, a substantially constant suction (or varying according to the characteristics of the spring 13) being established in the chamber 9 comprised between the two throttle members 2 and 3. The valve 3 could be replaced by equivalent throttle members, of which examples have been described in the above-said patent.

The abovesaid injection means are constituted by a source of fuel under pressure which will be described in more detail below and of which the delivery circuit opening into the pipe 1 downstream of the main throttle member 2 is controlled by at least one valve 16 actuated by an electromagnet 17.

The metering system is made to include a flat and opaque disc 18 which is borne by a shaft 19, connected preferably to the internal combustion engine (not shown) supplied by the device, so that the disc is driven in continuous rotation around an axis perpendicular to its plane. The disc 18 is interposed between a radiation or light source 20 and a radiation receiver such as a photodiode or photoelectric cell 21, borne by a common support 22 connected to the auxiliary throttle member 3 and it is pierced by at least one window 23 adapted to allow the radiation beam emerging from the source 20 to arrive at the cell 21. The cell 21 is arranged to actuate the energization of the electromagnet 17 according as it is irradiated or not and the assembly is such that the electromagnet is energized over a fraction of each of the revolutions of the disc 18 which varies in the same sense as the degree of opening of the throttle member 3.

The radiation source 20 can be constituted by a lamp which is adapted to be supplied by a battery 24 as soon as the ignition contact 25 of the engine is closed and which is arranged in a hollow boss 26 pierced by a hole. This hole is oriented in such a way as to direct a light beam on to the cell 21, through a hole passing through a hollow boss 27 where the said cell is housed.

In the embodiment shown, the bosses 26 and 27 are carried by the ends of the U-support 22 which straddles the disc 18 so that the source 20 and the cell 21 are on opposite sides of the disc and which is rigidly fixed to the axle 4, the latter being parallel to the shaft 19 as well as to the light beam received by the cell 21.

To utilize the currents generated in the cell 21, there may be inserted between the latter and the electromagnet 17, an amplifying relay 28.

When the internal combustion engine possesses several cylinders each supplied by a valve 16 actuated by an individual electromagnet 17, all the electromagnets can be actuated simultaneously or by means of a distributor 30 synchronized with the disc 18 in order to send successively the intermittent energizing current into the different electromagnets, the disc possessing as many windows 23 as cylinders to be supplied. These windows are distributed regularly around the shaft 19 and each have a shape such that a fraction of a turn of disc 18 during which it enables the cell 21 to be irradiated normally increases in proportion as the throttle member 3 opens, that is (in the embodiment shown) in proportion as the bosses 26, 27 approach the shaft 19.

It is known that the supply device which has just been described has the following operation.

In proportion as the flow of air in the pipe 1 increases, the throttle member 3 opens thereby driving the support 22 in the direction which brings the bosses 26 and 27 closer to the shaft 19. Each of the positions of the bosses corresponds to a different radius of the disc 18.

Since the shape of each window 23 has been determined so that the fraction of a turn during which it allows the light ray from the source 20 to pass towards the cell 21 (creation of a current in the conductor 31) increases in proportion as the latter elements 20, 21 approach the shaft 19, it is ensured that the flow of fuel delivered by each injection valve 16 varies in the same sense as the flow of air in the pipe 1.

Having arranged this, the source of fuel under pressure is constituted by a fuel pump 50 of which the suction pipe 51 dips into a fuel reservoir 52 and on the delivery pipe 53 of which acts a pressure regulator 54. The latter comprises a discharge valve 55 tending to open under the effect of the delivery pressure of the pump and to close under the effect of the suction existing in the chamber 9, which suction is transmitted through a linking channel 56 onto a diaphragm 57 to which the valve 55 is coupled by a rod 58. The valve 55 cooperates with a seat 59 which constitutes the outlet from a chamber 60 connected through a by-pass linking channel 61 to the delivery pipe 53. The linking channel 56 ends at a variable volume chamber 62 limited by one face of the diaphragm, the other face being placed at atmospheric pressure, for example through an orifice 63. The assembly is such that the valve 55 opens as soon as the pressure in the pipe 53 exceeds a value determined by the surface of the diaphragm 57 and by the suction exerted on the latter.

Assuming that the intake pipe 1 comprises, downstream of the main throttle member 2, a volume 64 large with respect to the stroke volume of the engine, according to the invention, there is arranged on the linking channel 56 throttle means 65 ensuring a flow section smaller in the direction a (FIG. 1) going from the chamber 9 to the chamber 62 limited by the diaphragm 57 than in reverse direction (direction *b*).

Advantageously, the throttle means 65 are constituted by two calibrated orifices 66*a* and 66*b*, mounted respectively in the two parallel branches 56*a* and 56*b* of the linking channel 56, and by a non-return valve 67 urged by a spring 68, which valve is arranged in series with one (66*b*) of the calibrated orifices and arranged to allow air to pass in the second above-indicated direction (direction *b*).

The operation of the supplementary means according to the present improvements is as follows.

In the case of deceleration, i.e. on closing of the main throttle member 2, the flow of air entering the volume 64 is smaller than that which is admitted to the engine, since the pressure in this volume 64 diminishes. Since the position of the auxiliary throttle member 3 measures the flow of air passing through it, and not that which is absorbed by the engine, there is as a result an air/fuel mixture which is too poor in fuel. However, according to the said improvements, the speed of drop in fuel pressure, on deceleration, is limited by the presence of the orifice 66*a*. In fact, to lower the fuel pressure, air must flow in the direction of the arrow *a*. Since the spring 68 supports the valve 67 on its

seat, air can only pass through the orifice **66***a*. The speed of drop in fuel pressure is all the less as the orifice **66***a* is smaller.

On acceleration, in similar manner, the speed of increase in fuel pressure is limited. In this case, air flows in the direction of the arrow b and the air passes through the two orifices **66***a* and **66***b*.

A judicious choice of these two orifices thus enables an almost constant richness of air/fuel mixture to be maintained, even during transient conditions (acceleration and deceleration) of the internal combustion engine.

As is self-evident and as emerges already from the preceding description, the invention is in no way limited to those of its methods of application, nor to those of its methods of production of its various parts, which have been more especially indicated; it encompasses, on the contrary, all variations.

I Claim:

1. Fuel feed device, for an internal combustion engine, which comprises, in its intake pipe upstream of a main throttle member actuated by the driver, an auxiliary throttle member which opens automatically and progressively in proportion as the flow of air in the said pipe increases, means for injecting liquid fuel under pressure into that portion of said pipe situated downstream of the main throttle member, and a metering system sensitive to the position of the auxiliary throttle member and adapted to regulate the flow of fuel injected in such a way that the richness of the air/fuel mixture passing into the intake pipe is substantially constant, at least for certain operational conditions of the engine, said injection means being constituted by a source of fuel under pressure of which the delivery circuit opening into said portion of the intake pipe is controlled by at least one valve actuated by an electromagnet, the metering system comprising 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 the valve, said system being arranged so that it increases and decreases said fraction in proportion as the opening of the auxiliary throttle member increases and decreases respectively, said source of fuel under pressure being constituted by a fuel pump on the delivery pipe of which pump a pressure regulator acts, said regulator comprising a discharge valve tending to open under the effect of the delivery pressure of the pump and to close under the effect of the suction existing in the section of the intake pipe comprised between its two throttle members, a linking channel transmitting said suction on to a diaphragm to which the discharge valve is coupled, throttle means being arranged on said linking pipe to ensure a smaller flow cross-section in the direction going from said section of the intake pipe to the diaphragm of the pressure regulator than in the reverse direction.

2. Fuel feed device according to claim **1**, wherein the throttle means are constituted by two calibrated orifices, mounted respectively in two parallel branches of the linking pipe, and by a non-return valve arranged in series with one of the calibrated orifices and arranged to allow air to pass in said reverse direction.

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