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Mennesson

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

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[51] **Int. Cl.** **F02m 51/00**

[58] **Field of Search**.....123/32 EA, 32 AE, 119 R, 139 AW, 123/148 E, 146.5 A, 32, 119

[56] **References Cited**

UNITED STATES PATENTS

3,522,794	8/1970	Reichardt	123/32 EA
3,543,739	12/1970	Mennesson	123/32 EA
3,430,616	3/1969	Glockler et al	123/32 EA

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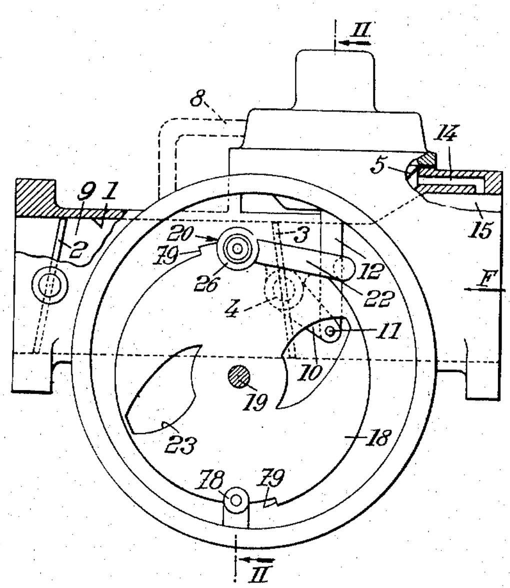
[57] **ABSTRACT**

Several valves supplied by a source of fuel under pressure are each actuated by an electromagnet energized over a variable fraction of each revolution of a rotary member driven by the engine. The energizing current passes through a distributor constituted by a light source, two photodiodes and electronic gates, the rotary member allowing the light source to illuminate or not the photodiodes according to its angular position.

2 Claims, 4 Drawing Figures



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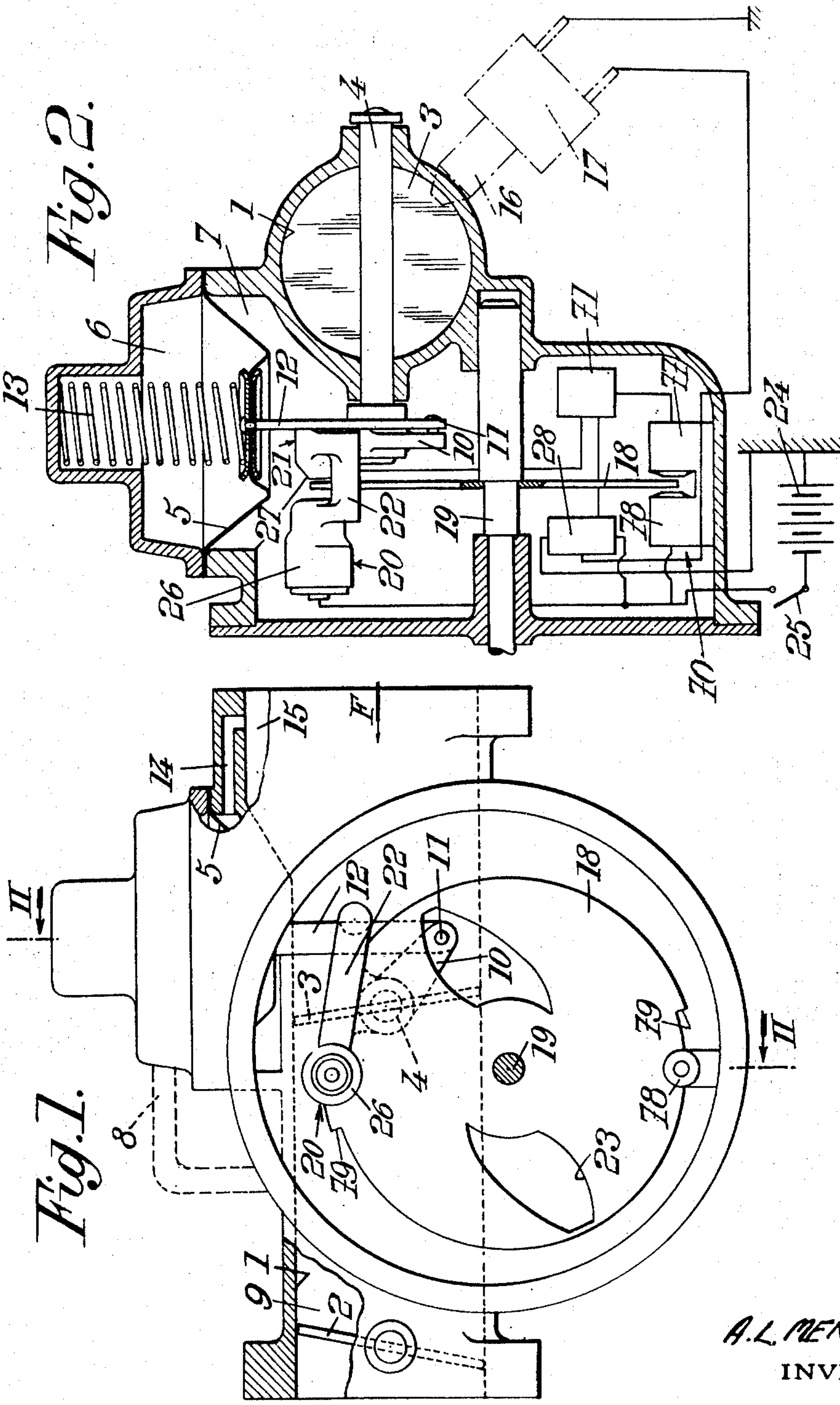

Fig. 1.

Fig. 2.

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Fig. 3.

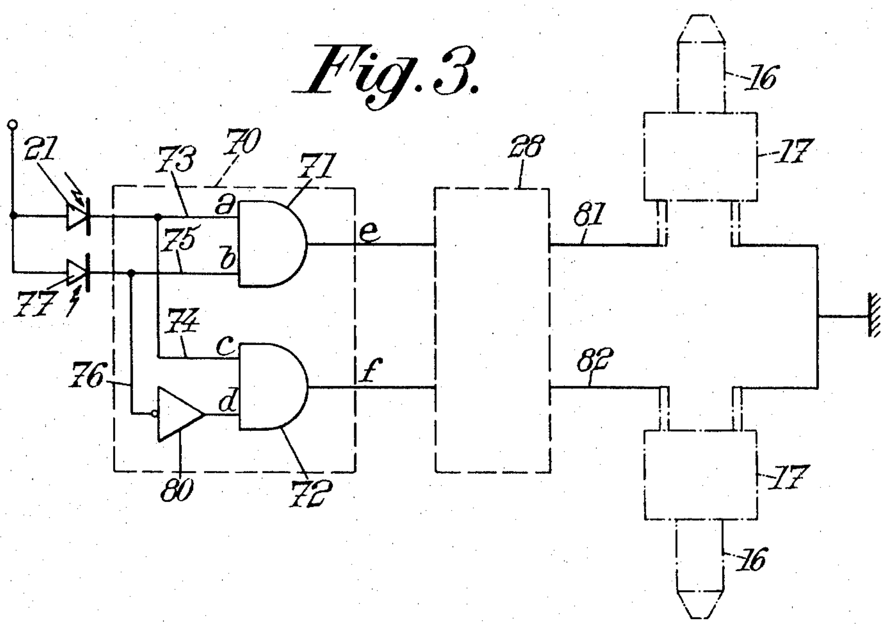
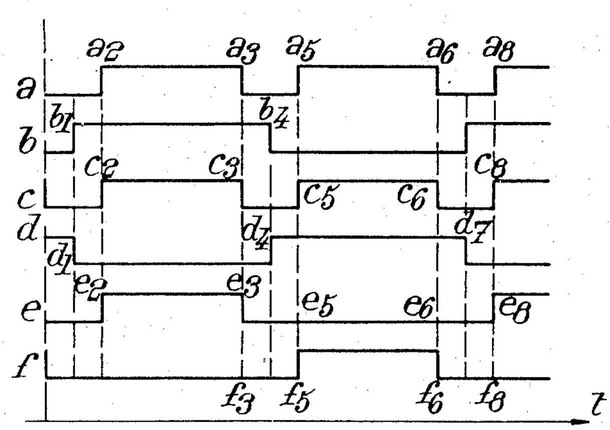


Fig. 4.



FUEL FEED DEVICES FOR INTERNAL COMBUSTION 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 main throttle member actuated by the driver, an auxiliary throttle member which is opened automatically and progressively in proportion as the flow of air in the said pipe increases and on the other hand, means for injecting liquid fuel under pressure into the 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 rate of the 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 abovesaid portion of the intake pipe, is controlled by several valves each actuated by an electromagnet.

The invention relates more particularly to those of the devices of the type concerned which have been described in United States patent of Applicant U.S. Pat. No. 3,543,739, and of which the abovesaid metering system comprises a member driven in continuous rotation by the internal combustion engine, and capable, by acting on the energizing of each electromagnet, of determining over a fraction only of each of its turns the opening of the valve actuated by this electromagnet, the system being arranged so that it increases the said fraction in proportion as the opening of the auxiliary throttle member increases and vice-versa.

The invention relates more particularly, but not exclusively, among these devices, to those of which the abovesaid continuously rotating member comprises means adapted to emit, towards a stationary receiver , a flow of energy during a fraction of a turn of which member the value varies as a function of the relative positions of the rotary member and of the receiver, this receiver being arranged so that it creates an energizing current for the abovesaid electromagnets according as it receives or not the flow of energy, and the auxiliary throttle member being arranged to modify the relative positions of the rotary member and of the receiver ; the means emitting the flow of energy being capable of being a light source and the receiver a photosensitive element such as a photodiode, the light source and the photosensitive element being arranged on opposite sides of the abovesaid rotary member which is arranged as an opaque screen pierced by at least one aperture to enable the illumination of the photosensitive element.

The rotary member is advantageously constituted by a flat and opaque disc perpendicular to its axis of rotation, the stationary receiver being such that it can be brought nearer or spaced further from this axis.

United States patent of Applicant U.S. Pat. No. 3,543,739, describes particularly, for internal combustion engines having several cylinders (or groups of cylinders) which are each supplied by a valve actuated by its individual electromagnet, a feed device comprising a distributor synchronized with said rotary member to send successively the intermittent energizing current into the various electromagnets.

The distributor described in more detail comprises moving mechanical parts, producing wear and noise and being relatively bulky.

It is an object of the present improvements to overcome these drawbacks.

To this end, the fuel feed device according to the principal patent, which comprises a distributor synchronized with the rotary member to send successively the intermittent energizing current into the various electromagnets, is characterized by the fact that the distributor is constituted by at least one assembly comprising a light source, a photosensitive element and electronic gates, the light source and the photosensitive element being arranged on opposite sides of the rotary member so that the latter, according to its angular position, interrupts or not the luminous beam between the light source and the photosensitive element and the assembly being such that this photosensitive element directs or not, according as it is illuminated or not, a control current towards the gates so that the latter, in their turn, direct the energizing current successively towards the various electromagnets.

According to the above-indicated preferred embodiment where the metering system comprises a light source and a photosensitive element arranged on opposite sides of the rotary member arranged as an opaque screen pierced by apertures to enable the illumination of this photosensitive element during a fraction of a turn of the rotary member which depends on the position of the auxiliary throttle member, the feed device is , in addition, characterized by the fact that the photosensitive element of the metering system acts in combination with the photosensitive element of the distributor to control the gates of the distributor.

The invention will, in any case, be well understood with the aid of the supplementary description which follows, as well as of the accompanying drawings, which supplement and drawings relate to a preferred embodiment, given purely by way of illustrative and non-limiting example.

In the drawings :

FIG. **1** shows, in diagrammatic elevation with portions in section, a feed device constructed according to the invention ;

FIG. **2** shows a section of the device along the line II—II of FIG. **1** ;

FIG. **3** shows the electronic circuit of the embodiment shown in FIG. **2** ; and lastly,

FIG. **4** shows the voltage levels at various points of FIG. **3**.

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

As regards the device as a whole, it is constituted in any suitable manner such that it comprises (FIGS. **1** and **2**) :

on one hand, in its intake pipe **1**, upstream of the main throttle member **2** actuated by the driver, an auxiliary throttle member **3** which is opened automatically and progressively in proportion as the flow rate of the 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 ;

and on the other hand lastly, a metering system sensitive to the position of the auxiliary throttle member 3 and adapted to regulate in such a manner the flow of fuel injected 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 butterfly 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 through a channel 8 to a chamber 9 constituted by the section 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 constantly tends 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 passage 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 rate of the air in this pipe. The greater the flow rate of the air, the more the valve 3 is opened, 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 United States patent of Applicant U.S. Pat. No. 3,543,739.

The abovesaid injection means are constituted by a source of fuel under pressure (not shown) of which the delivery circuit, opening into the pipe 1 downstream of the main throttle member 2, is controlled by valves such as 16 each actuated by an electromagnet 17.

The metering system is made to comprise a flat and opaque disc 18 which is borne by a shaft 19 connected to the internal combustion engine (not shown) supplied by the device, so that the disc is rotated continuously around an axis perpendicular to its plane. The disc 18 is interposed between a light source 20 and a photodiode 21 borne by a common support 22 connected to the auxiliary throttle member 3 and it is pierced by apertures 23 adapted to allow the beam emerging from the source 20 to reach the photodiode 21. The photodiode 21 is arranged to create or not an energizing current for the electromagnet 17 according as it is illuminated or not and the assembly is such that this current is created over a fraction of each of the turns of the disc 18 which varies in the same sense as the degree of opening of the throttle member 3.

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

In the embodiment shown, the bosses 26 and 27 are caused to be borne by the ends of the U-shaped support 22 which straddles the disc 18 so that the source 20 and the photodiode 21 occur on both 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 photodiode 21.

To apply the currents generated in the photodiode 21, there is interposed between the latter and the electromagnet 17, a distributor 70 and am amplifier 28.

The distributor 70 is synchronized with the disc 18 to send successively the intermittent energizing current into the different electromagnets, the disc possessing as many apertures 23 as cylinders or groups of cylinders to be supplied. These apertures are distributed regularly around the shaft 19 and each has a shape such that the fraction of a turn during which it normally enables the photodiode 21 to be illuminated increases in proportion as the throttle member 3 is opened, that is to say (in the embodiment shown) in proportion as the bosses 26, 27 approach the shaft 19.

Of course the feed device which has just been described has the following operation.

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

Since the shape of each aperture 23 has been determined in such a way that the fraction of a turn of disc 18 during which it allows the light ray to pass, emerging from the source 20, to the photodiode 21 increases in proportion as the latter elements approach the shaft 19, it is ensured that the flow rate of the fuel delivered by each injection valve 16 varies in the same sense as the flow rate of the air in the pipe 1.

Having recalled this and according to the present improvements, in the case where it is desired to associate with the distributor 70, two electromagnets 17 (as shown in FIG. 3) or two groups of such electromagnets, the distributor is made to comprise two AND gates 71 and 72. Onto each of these gates, there is sent, on one hand, through two conductors 73 and 74, the electrical signal supplied by the photodiode 21 and, on the other hand, by two conductors 75 and 76, the electrical signal furnished by a second photodiode 77 which is fixed opposite a second light source 78, so that the disc 18 placed between the source 78 and the photodiode 77 can or cannot interrupt the light beam emerging from the source 78, according to its angular position. To this end, the disc 18 can be constituted by two semicircles of different diameters connected by steps 79 and the photodiode 77 and the source 78 can be situated at the level of the outer edge of the disc 18 as shown in FIGS. 1 and 2.

The electrical signal furnished by the photodiode 77 is sent directly through the conductor 75 onto the gate 71 and, by means of an inverter 80, onto the gate 72 ; the outputs e and f of the gates 71 and 72 are amplified by the amplifier 28 and the amplified current is applied to two electromagnets 17 through conductors 81 and 82.

The operation of the distributor is explained by means of FIG. 4 where there have been shown, as a function of time t, the voltages at the points a, b, c, d, e and f. The voltages a and b are those of the currents provided respectively from photodiodes **21** and **77** and entering the gate **71**. The voltages *c* and *d* are those of the currents entering the gate **72**, the first coming from the photodiode **21** and the second coming, after having been inverted, from the photodiode **77**.

If the photodiode **21** is not illuminated (segments a_3–a_5 and a_6–a_8), the two gates **71** and **72** are blocked and no current circulates in the conductors **81** and **82** (segments e_3–3_5 ; e_6–e_8 ; f_3–f_5 ; f_6–f_8). If the photodiode **21** is illuminated, on account of the inverter **80**, one only of the gates **71** and **72** delivers an electrical signal to the point *e* or *f* according as the photodiode **77** is illuminated or not. More specifically, when the photodiode **77** is illuminated, it passes a current at b_1–b_4 ; the gate **71** allows the current emerging from the photodiode **21** to pass, as shown at e_2–e_3 ; on the contrary, when the photodiode **77** is not illuminated, the gate **72** allows the current emerging from the photodiode **21** to pass, as seen at f_5–f_6.

Consequently, current flows in the conductor **81** or **82** and one of the valves **16** is open. Thus as has been shown in FIG. **4**, it is arranged for the change of state of the photodiode **77** to be effected always whilst the photodiode **21** is not illuminated. The time of opening of the valve **16** must only be controlled by the time of illumination of the photodiode **21**.

There has thus been provided a simple current distributing device which could be easily adapted to the case where it would be necessary to distribute the current over a number of channels greater than two. It suffices to provide a number of fixed photodiodes such as **77** and of AND gates such as **71** and **72** equal to the number of channels. The electrical current in one channel is then obtained by simultaneous illumination of the movable photodiode **21** and the fixed photodiode such as **77** corresponding to the channel.

As is self-evident and as emerges already from the foregoing, 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 is opened automatically and progressively in proportion as the air flow in the said pipe increases, means for injecting under pressure liquid fuel into the portion of this 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 conditions of operation 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 several valves each actuated by an electromagnet, the metering system comprising a light source and a photo-sensitive element arranged on opposite sides of a rotary member driven in continuous rotation by the internal combustion engine and adapted as an opaque shutter pierced by windows to enable the illumination of said photo-sensitive element during a fraction of a turn of the rotary member which fraction depends on the position of the auxiliary throttle member, said system being arranged so that it increases said fraction in proportion as the opening of the auxiliary throttle member increases and vice-versa, which fuel feed device comprises a distributor synchronized with the rotary member to send successively the intermittent energizing current into the various electromagnets, characterized by the fact that the distributor is constituted by at least one assembly comprising a light source, a photo-sensitive element and electronic gates, the light source and photo-sensitive element being arranged on opposite sides of the rotary member so that the latter, according to its angular position, interrupts or not the light beam between the light source and the photo-sensitive element, said assembly being adapted to cause said latter photo-sensitive element to direct, according as it is illuminated or not, a control current towards the gates so that the latter, in their turn, direct the energizing current successively towards the various electromagnets, the photo-sensitive element of the metering system acting in com-bination with the photo-sensitive element of the distributor to control the gates of the distributor.

2. Fuel feed device according to claim **1** comprising two electronic gates of the AND type, with two inputs, the rotary member possessing two windows displaced by **280°** and the photosensitive elements being photodiodes, the photodiode of the metering system and that of the one or more of the above-mentioned assemblies both having their outputs connected to the inputs of the AND gates, the output of the photodiode of the metering system being connected directly onto the input of one of the AND gates and by way of an inverter onto the input of the other AND gate and the outputs of the AND gates being connected respectively to two electromagnets or groups of electromagnets.

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