United States Patent

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Neuilly-sur-Seine, France
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[33] **France**
[31] **177,509**

[54] **FUEL FEED DEVICES FOR INTERNAL COMBUSTION ENGINES**
6 Claims, 8 Drawing Figs.

[52] **U.S. Cl.** ....**123/139AW,** 123/32 AE, 123/32 EA, 123/97 B, 123/119, 123/140 MC, 123/179 A
[51] **Int. Cl.** **F02m 39/00,** F02d 1/04
[50] **Field of Search** .... 123/179 A, 179, 139 AW, 32 AE, 32 EA, 119, 97 B, 140 MC

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ABSTRACT: The induction pipe includes a throttle valve controlled by the driver and an auxiliary throttle member which opens automatically as a function of the airflow. An eccentric butterfly valve opens under the influence of the airflow and contrary to the variable resilient action of a member responsive to the engine temperature. A passage short circuits the throttle and is progressively closed by a piston proportionately with the opening of the eccentric butterfly valve as the engine heats up.

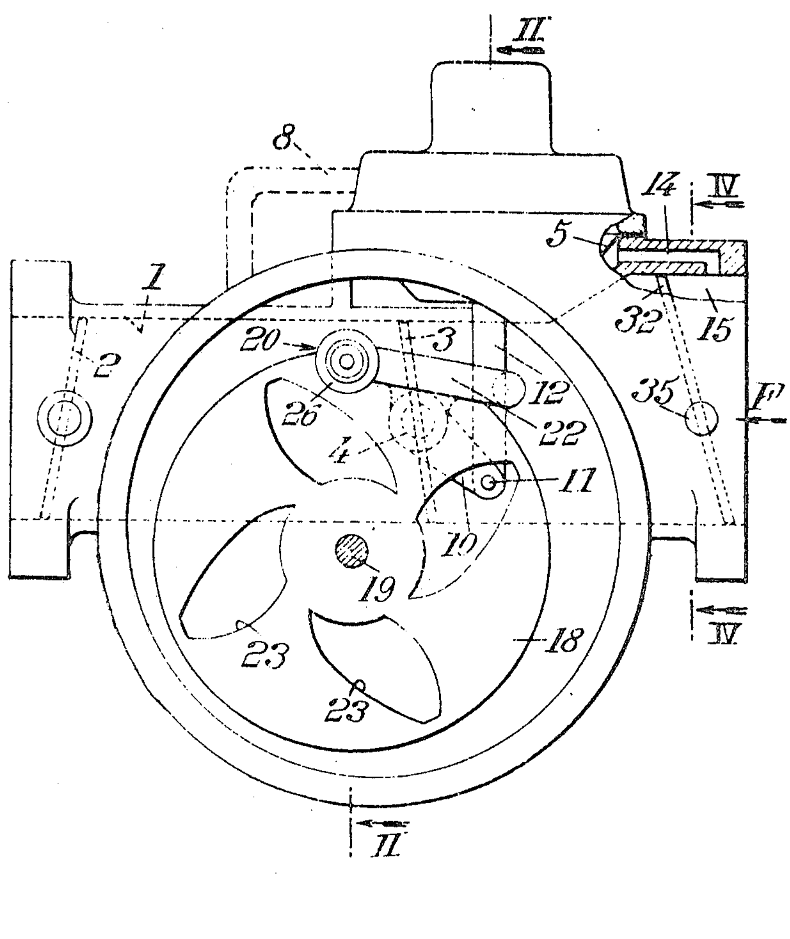

Fig.1.

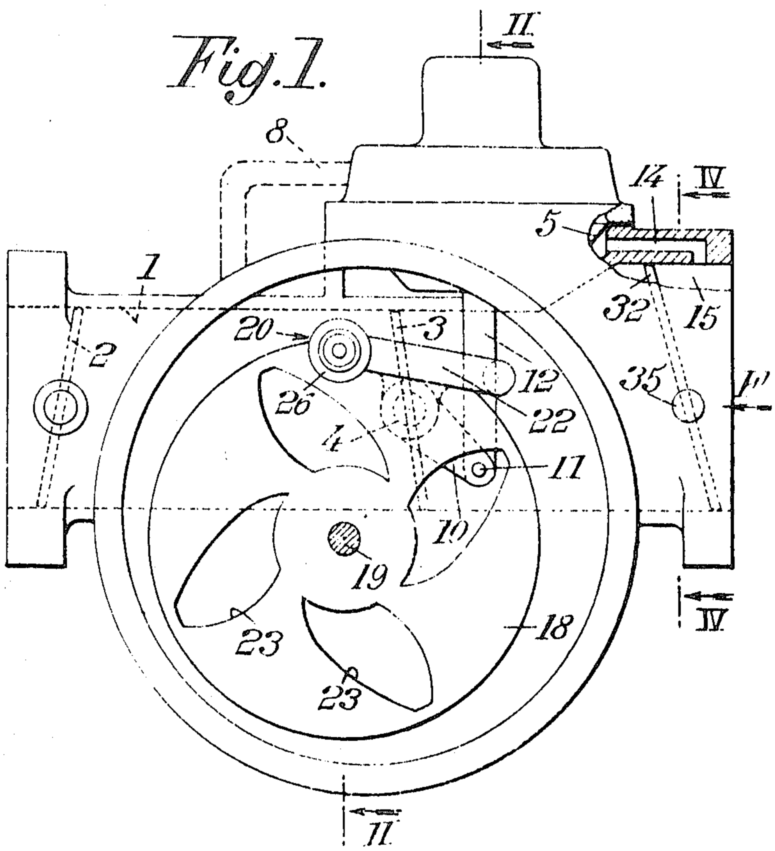

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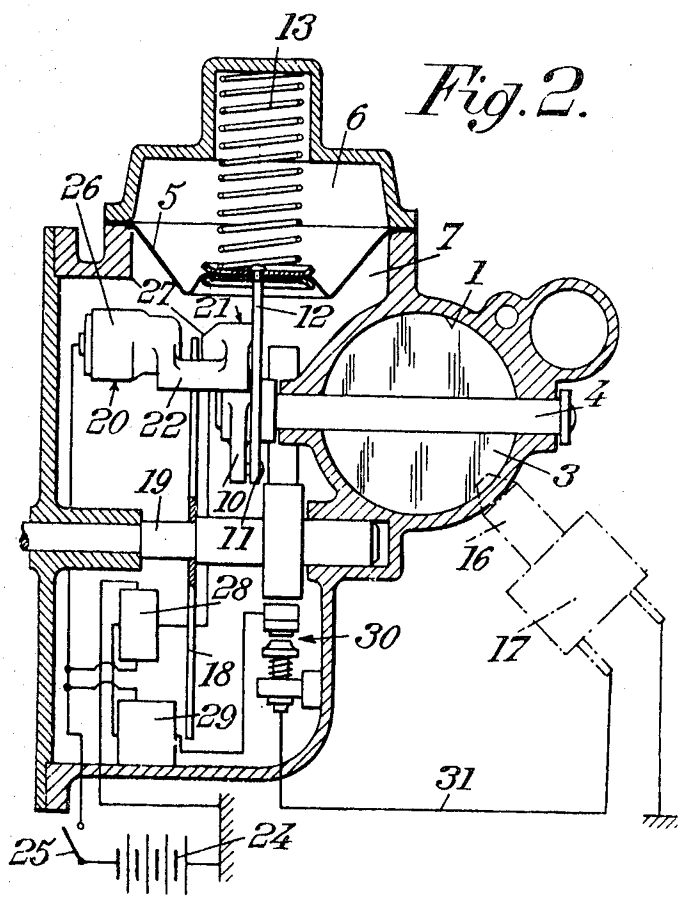
Fig. 2.



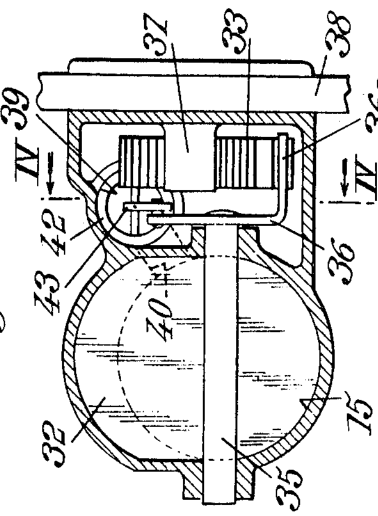


Fig. 3.

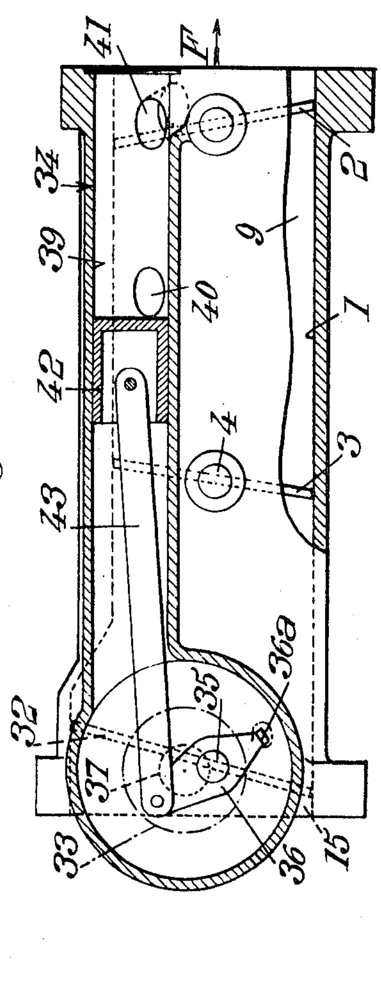


Fig. 4.

Fig.5.

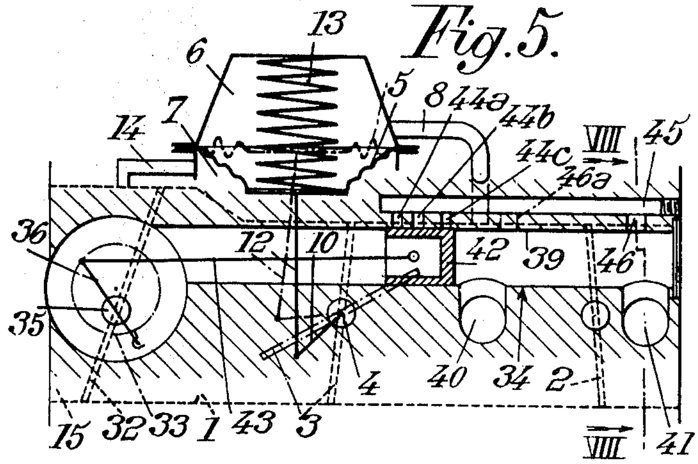
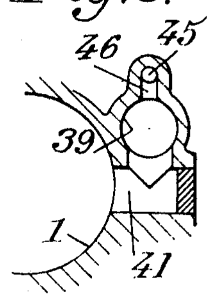


Fig.8.



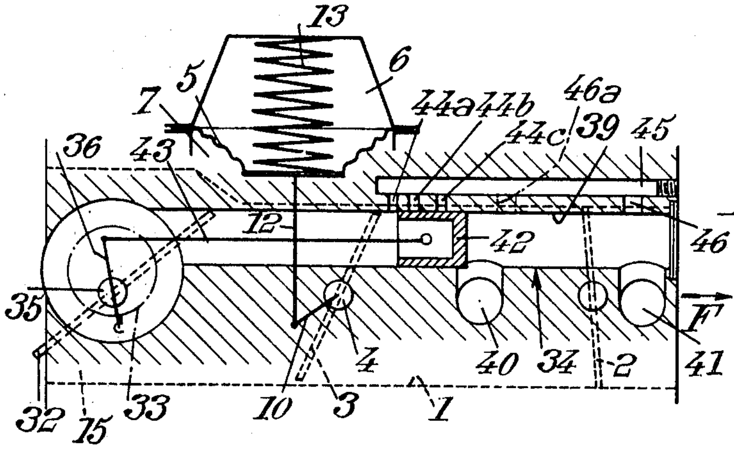


Fig.6.

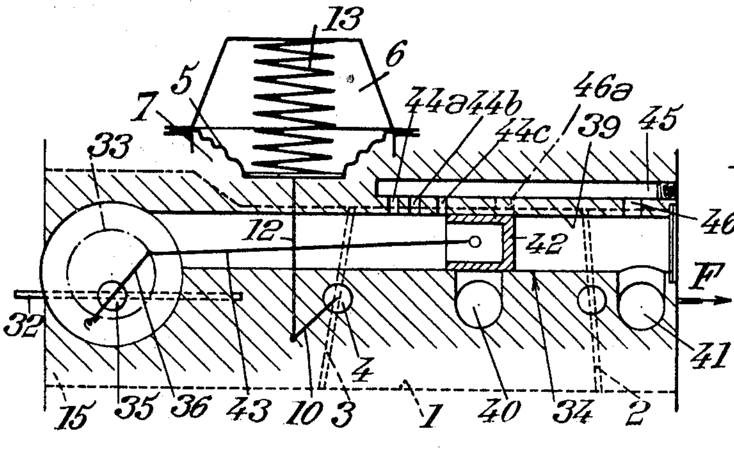


Fig.7.

FUEL FEED DEVICES FOR INTERNAL COMBUSTION ENGINES

This invention relates to fuel feed devices for internal combustion engines, of the type comprising in the induction pipe, upstream of a main throttling member operated by the driver, an auxiliary throttling member which opens automatically and progressively as the rate of airflow in the said pipe increases; means for injecting liquid fuel under pressure into that portion of the induction pipe downstream of the main throttling member; and a metering system adapted to respond to the position of the auxiliary throttling member and so to regulate the rate of flow of the fuel injected that the richness of the fuel-air mixture entering the induction pipe is substantially constant, at least for certain running conditions of the engine, the said injection means being the form of a source of fuel under pressure of which the delivery circuit, leading into the said portion of the induction pipe, is controlled by at least one valve operated by an electromagnet.

The invention relates more particularly to those devices of this type in which the metering system comprises a member adapted to be rotated continuously, preferably by the internal combustion engine, and capable, by affecting energization of the electromagnet, of causing opening of the valve during only a fraction of each of its revolutions, this system being so arranged that it increases this fraction the further the auxiliary throttling member opens, and vice versa.

The invention relates more particularly, but not exclusively, to devices of this type in which the member adapted to be continuously rotated has means for transmitting to a stationary receiver a flow of energy during a fraction of a revolution whose value varies according to the relative positions of the rotary member and receiver, the receiver being such that it controls the energizing circuit for the electromagnet according to whether or not it receives the flow of energy, and the auxiliary throttling member being such as to modify the relative positions of the rotary member and receiver; the means for emitting the flow of energy may be a light source, and the receiver may be a photoelectric cell, the source and cell being situated on each side of the said member, which forms an opaque screen containing at least one port to permit illumination of the cell.

The rotary member is advantageously in the form of a flat, opaque disc perpendicular to its axis of rotation, the stationary receiver being such that it can be brought closer to or further from this axis.

When an internal combustion engine is started and is running cold, of course, both the rate of air flow and the richness of the fuel-air mixture must be greater than under idling conditions for a hot engine, the increase preferably being greater, the colder the engine is.

In conventional carburetion devices, in which the fuel is drawn in due to the underpressure prevailing at a venturi upstream of the main throttling member, this may be done by partly opening the main throttling member and by increasing the underpressure by means of an eccentric butterfly valve upstream of the venturi, this valve being adapted to open under the influence of the flow of air and contrary to the variable resilient action of a temperature-responsive member (more particularly a bimetal spiral).

The object of the invention is to make feed devices as described above such that they adapt automatically to the requirements of the engine supplied by them when this engine is cold.

The feed device of the type described is characterized in that in the induction pipe, upstream of the auxiliary throttling member, there is an eccentric butterfly valve adapted to open under the influence of the flow of air and contrary to the variable resilient action of a member adapted to respond to the engine temperature, and between the space defined in the pipe by the two main and auxiliary throttling members and that zone of the pipe downstream of the main throttling member there is a passage short circuiting the latter throttling member, means being provided for progressive throttling of the passage as the eccentric butterfly valve opens when the engine heats up.

The invention will in any case be clear from the following description and the accompanying drawings, relating to a preferred embodiment.

FIG. 1 of the drawings shows, by means of a diagrammatic elevation with parts in section, a feed device embodying the invention, the components of this device being in the position for normal running;

FIGS. 2, 3 and 4 respect sections along lines II—II and III—III in FIG. 1 and IV—IV in FIG. 3, respectively;

FIGS. 5 to 7 are views similar to FIG. 4, showing the essential components of the device in the positions occupied by them respectively when the cold engine is stationary, when the cold engine is idling and when the hot engine is idling; and

FIG. 8 shows a section along a line VIII—VIII in FIG. 5.

A fuel feed device for a vehicle engine or the like is constructed as follows or in a similar fashion.

As regards the device as a whole, it is constituted in any appropriate manner, in such a way that it comprises (FIG. 1): In the induction pipe **1**, upstream of a main throttling member **2** operated by the driver, an auxiliary throttling member **3** which opens automatically and progressively as the rate of airflow in the said pipe **1** increases; means for injecting liquid fuel under pressure into that portion of the induction pipe **1** downstream of the main throttling member **2**; and a metering system adapted to respond to the position of the auxiliary throttling member **3** and so to regulate the rate of flow of the fuel injected that the richness of the fuel-air mixture entering the induction pipe **1** is substantially constant, at least for certain running conditions of the engine.

According to the embodiment illustrated, the auxiliary throttling member **3** is in the form of a butterfly valve keyed on a pivot **4**. This butterfly valve is operated by a pneumatic device with a diaphragm **5** which separates two chambers **6**, **7** from one another. The chamber **6** is connected by a duct **8** to a chamber **9** formed by that portion of the pipe **1** between the main throttling member **2** and the butterfly valve **3**. The pivot **4** is attached to a lever **10** whose free end bears a detent **11** cooperating with the end of a rod **12** connected to the diaphragm **5**. A spring **13** tends to close the butterfly valve **3**, counteracting the influence of the underpressure transmitted in the chamber **6**. The chamber **7** is connected to the atmosphere by a duct **14**, preferably running from the air intake **15** of the duct **1**.

The angular position of the butterfly valve **3** within the pipe **1** at any time corresponds, of course, to the rate of airflow in this pipe. The higher this rate of flow, the more the butterfly valve **3** opens, a substantially constant underpressure (or an underpressure varying according to the characteristics of the spring **13**) establishing itself in the chamber **9** between the two throttling members **2**, **3**. Equivalent throttling members might be substituted for the butterfly valve **3**.

The injection means mentioned are in the form of a source of fuel under pressure (not shown) of which the delivery circuit, which joins the pipe **1** downstream of the main throttling member **2**, is controlled by at least one valve **16** operated by an electromagnet **17**.

The metering system comprises a flat, opaque disc **18** which is mounted on a shaft **19** connected to a motor, for example the internal combustion engine (not shown) supplied by the device, in such a way that the disc is rotated continuously about an axis perpendicular to its plane. The disc **18** is placed between a light source **20** and a photoelectric cell **21** mounted on a common support **22** connected to the auxiliary throttling member **3**, and it contains at least one port **23** adapted to admit the beam from the light source **20** to the photoelectric cell **21**. The cell **21** is adapted to cause energization of the electromagnet **16**, depending on whether or not it is illuminated, the assembly as a whole being such that the electromagnet is energized during a fraction of each revolution of the disc **18** which varies in the same direction as the degree of opening of the auxiliary throttling member **3**.

The light source 20 may be in the form of a lamp which can be supplied by a battery 24 once the engine ignition switch 25 is on, and which is housed in a hollow boss 26 containing a hole. This hole is so arranged that it directs a light beam onto the cell 21, through a hole in a hollow boss 27 housing this cell.

In the embodiment illustrated, the bosses 26, 27 are mounted on the ends of the U-shaped support 22, which is placed astride the disc 18 so that the source 20 and cell 21 are on opposite sides of this disc and which is attached to the pivot 4, the latter being parallel to the shaft 19 and to the light beam received by the cell 21.

In order to make use of the currents produced in the cell 21, an amplifying relay 28 and possible an intensity limiting device 29 may be inserted between this cell and the electromagnet 17.

When the internal combustion engine has a plurality of cylinders, each supplied by a valve 16 operated by a separate electromagnet 17, a distributor 30 is provided, this distributor being synchronized with the disc 18 in order to supply the intermittent energizing current to the different electromagnets in succession, the disc having as many ports 23 as there are cylinders to be supplied. These ports are equispaced around the shaft 19, and each is shaped in such a way that the fraction of a revolution during which it normally permits illumination of the cell 21 increases as the throttling member 3 opens, that is to say, (according to the embodiment illustrated), as the bosses 26, 27 come nearer to the shaft 19.

The feed device just recalled operates, of course, as follows:

As the rate of airflow in the pipe 1 increases, the throttling member 3 opens, moving the support 22 in the direction which brings the shaft 19 nearer the bosses 26, 27. Each of the positions of these bosses corresponds to a different radius of the disc 18. Since the shape of each port 23 has been selected so that the fraction of a revolution during which it admits the light ray from the source 20 to the cell 21 (a current being produced in the lead 31) increases, the nearer the latter elements come to the shaft 19, the rate at which fuel is supplied by each injection valve 16 will necessarily vary in the same direction as the rate of airflow in the pipe 1.

Under these conditions, in the induction pipe 1 upstream of the auxiliary throttling member 3 (that is, in the air intake 15) there is an eccentric butterfly valve 32 adapted to open under the influence of the flow of air (flowing in the direction of arrows F) and contrary to the variable resilient action of a member 33 adapted to respond to the engine temperature, and between the chamber 9 defined in the pipe 1 by the throttling member 2, 3 and that zone of the pipe 1 downstream of the main throttling member 2 there is a passage 34 short circuiting the latter throttling member 2, means being provided for progressive throttling of the passage 34 as the eccentric butterfly valve 32 opens when the engine heats up.

In the embodiment illustrated, the butterfly valve 32 is mounted on a pivot 35 attached to a double lever 36 of which one end 36*a*, which is bent, cooperates with the outer end of the member 33, which is in the form of a bimetal spiral and is shown in section in FIG. 1 and by means of a chain-line circle in FIGS. 4 to 7. The said end is adapted to turn clockwise (FIGS. 4 to 7) when the member 33 heats up, the central coil of the latter being attached to a hub 37 whose temperature varies with that of the engine. The hub 37 may, for example, be heated by a pipe 38 (FIG. 3) traversed by a fluid such as the cooling water or lubricating oil for the engine or air previously heated by the exhaust gases. Alternatively, it may be heated by an electrical resistance to which current is supplied when the ignition switch 25 is on.

Advantageously, the passage 34 is formed by a portion of a cylindrical bore 39, whose axis is advantageously parallel to that of the pipe 1, and by two orifices 40, 41 connecting this bore to the pipe 1 and coming out respectively between the throttling members 2 and 3 and downstream of the throttling member 2. If so, the means for progressively throttling the passage 34 are a piston 42 housing in the bore 39 at the level of the orifice 40 and attached to that end of the lever 36 remote from the end 36*a*, for example by means of a link 43, the whole being such that the underpressure transmitted in the passage 34 tends to displace the piston 42 in the direction which produces greater throttling of the orifice 40.

Preferably, also, that portion of the bore 39 remote from the passage 34 by comparison with the piston 42 is connected to the induction pipe 1 downstream of the main throttling member 2 by way of orifices such as 44*a*, 44*b*, 44*c* of small cross section, adapted to be revealed successively by the piston 42 as the latter is displaced due to the underpressure in the passage 34. To this end, the orifices 44*a* to 44*c* may be connected to a duct 45 connected to a point downstream of the main throttling member, preferably by way of the passage 34, to which it is connected by an orifice 46.

This orifice 46 may be situated either as indicated by solid lines in FIGS. 5 to 7, so that is is permanently open, or as indicated by chain lines at 46*a* in these figures, so that it is not revealed by the piston 42 except when the latter is in positions corresponding to closing or partial opening of the butterfly valve 32.

Lastly, a connection may be provided between the main throttling member 2 and the butterfly valve 32 so that complete or substantially complete opening of the member 2 causes the butterfly valve 32 to open, overcoming the action of the thermostat member 33.

The resulting, improved feed device operates as follows:

When the engine is stationary and the engine temperature is low, the components occupy the positions shown in solid and broken lines in FIG. 5. The thermostat member 33 exerts an appreciable torque, which turns the lever 36 anticlockwise. The butterfly valve 32 is then closed, and the piston 42 reveals the whole of the orifice 40, but masks the orifices such as 44*a*. If the engine is started by means of the starter, the underpressure prevailing in the induction pipe 1 downstream of the throttling member is transmitted by the passage 34 to the chamber 9 between the two throttling members 2 and 3. This underpressure, also transmitted by the duct 8 to the chamber 6, counteracts the spring 13 and lifts the diaphragm 5, which takes up the position shown by chain lines in FIG. 5. This turns the pivot 4 and support 22 and displaces the assembly comprising the light source 20 and cell 21 (FIGS. 1 and 2) towards the shaft 19 for the disc 18, so increasing both the fraction of a revolution during which the injection valves 16 are open and the richness of the mixture in the pipe 1.

As soon as the support 22 is in the correct position for the starting mixture, the engine starts and picks up speed, and the underpressure downstream of the throttling member 2 increases abruptly, this underpressure being transmitted along the passage 34 and onto the right-hand end (FIGS. 4 to 7) of the piston 42. Similarly, by way of the auxiliary throttling member 3 which is fairly wide open (as shown by chain lines in FIG. 5), the underpressure is transmitted to the butterfly valve 32, whose flaps are asymmetrical, so producing an opening torque counteracting the resilient action of the bimetal spiral 33. These two actions cause the piston 42 to shift to the right and the butterfly valve 32 to be partially opened. This action continues until the orifice 44*a* is revealed by the piston 42, since at this instant this orifice transmits the underpressure prevailing in the pressure 34 to the left-hand end of the piston 42, partially neutralizing the effect of the underpressure on the right-hand end of this piston. In the resulting intermediate position (FIG. 6) the orifice 40 is partly closed and the butterfly valve 32 partly open. This is a position of equilibrium which corresponds to cold running of the engine, in which "accelerated"idling is caused by a relatively high flow of air through the passage 34. At the same time the richness of the mixture is sufficiently increased, since the butterfly valve 32, which is slightly open, produces a sufficient head loss for the auxiliary throttling member 3 to be further open than usual and for the position of the photoelectric cell 21 relative to the ports 23 in the disc 18 therefore to correspond to a slight increase in the richness of the mixture.

As the thermostat member **33** heats up, its resistant torque diminishes and the butterfly valve **32** therefore tends to open, the more so since a slight underpressure continues to act on the piston **42** due to the inevitable leaks occurring at the duct for the pivot **35**, so that the underpressure to the left of the piston **42** is never as great as that to the right of it.

As it advances, the piston **42** reveals the second orifice **44***b*, which corresponds to a second stabilizing position, and then the third orifice **44***c* which corresponds to the position (FIG. 7) in which the piston **42** closes the orifice **40** completely and the butterfly valve **32** is wide open. The positions now occupied are those corresponding to normal hot running of the engine.

If the orifice **46** is at **46***a*, that is to say, if it is obstructed when the butterfly valve **32** is fully open, the following supplementary advantages are obtained: a greater force acting on the piston **42** when the butterfly valve **32** is open, so that the inoperative position is better maintained; and better idling, due to the absence of leaks bringing air from the duct for the pivot **35** or from any other air inlet.

When, if a connection is provided between the main throttling member **2** and the butterfly valve **32**, the engine is accidentally flooded during starting, it is merely necessary to press on the accelerator to force the valve **32** open, so introducing a large quantity of air into the engine.

The advantage of the device just described is, firstly, that the air cross sections required for operation of the engine at all temperatures are provided automatically without intervention by the driver and, secondly, that the starting mixture need not be regulated, since the assembly comprising the photoelectric cell **21** and the light source **20** itself finds the optimum position for giving the correct starting mixture.

What I claim is:

1. In a fuel feed device for internal combustion engines, which comprises in the induction pipe, upstream of a main throttling member operated by the driver, an auxiliary throttling member which opens automatically and progressively as the rate of airflow in the said pipe increases; means for injecting liquid fuel under pressure into that portion of the induction pipe downstream of the main throttle member; and a metering system adapted to respond to the position of the auxiliary throttling member and so to regulate the rate of flow of the fuel injected that the richness of the fuel-air mixture entering the induction pipe is substantially constant, at least for certain running conditions of the engine, the said injection means being in the form of a source of fuel under pressure of which the delivery circuit, leading into the said portion of the induction pipe, is controlled by at least one valve operated by an electromagnet, the metering system comprising a member adapted to be rotated continuously and capable, by affecting energization of the electromagnet, of causing opening of the valve during only a fraction of each of its revolutions, this system being so arranged that it increases this fraction the further the auxiliary throttling member opens, and vice versa, the improvement comprising in the induction pipe, upstream of the auxiliary throttling member, an eccentric butterfly valve which opens under the influence of the flow of air and contrary to the variable resilient action of a member which responds to the engine temperature, and between the space defined in the pipe by the two main and auxiliary throttling members and that zone of the pipe downstream of the main throttling member a passage short circuiting the said main throttling member, means being provided for progressive throttling of the passage as the eccentric butterfly valve opens when the engine heats up.

2. The improvement of claim **1**, wherein the passage is a portion of a cylindrical bore connected to the induction pipe by an upstream orifice and a downstream orifice finishing on each side of the main throttling member, and the means for progressive throttling of said passage are a piston housed in the bore at the level of the upstream orifice and mechanically connected to the eccentric butterfly valve, the whole being such that suction transmitted in the passage tends to displace the piston in the direction of greater throttling of the upstream orifice.

3. The improvement of claim **2**, wherein the induction pipe, downstream of the main throttling member communicates with that portion of the bore which is remote from the passage relative to the piston, by way of restricted orifices adapted to be revealed successively by the piston as the latter is displaced due to the suction in the passage.

4. The improvement of claim **3**, wherein the restricted orifices communicate with a duct connected to the induction pipe downstream of the main throttling member, by way of the said passage.

5. The improvement of claim **4**, wherein the connection between the duct associated with the restricted orifices and the passage is such that is closed by the piston when the latter occupies the position in which the eccentric butterfly valve is wide open, but is open when the position is in positions corresponding to closing and partial opening of the butterfly valve.

6. The improvement of claim **1**, wherein the internal combustion engine rotates said member adapted to be continuously rotated.