

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

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[63] Continuation of Ser. No. 10,420, Feb. 11, 1970, abandoned.

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[51] Int. Cl. F02b 3/00, F02m 39/00

[58] Field of Search 123/32, 119 R, 139 AW

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[57] **ABSTRACT**

The fuel feed device includes a fuel injector controlled by an electromagnetic valve. A metering system has a rotary member adapted to send an energizing signal into the electromagnet during a fraction of each turn of the member. A signal generator is adapted to employ, on each turn of the rotary member, a release signal which lasts during a predetermined and constant fraction of a turn of the rotary member to produce the energizing signal whose duration varies in the same sense as that of the release signal and in the same sense as the degree of opening of an auxiliary throttle member in the intake pipe upstream of the main throttle. The auxiliary throttle opens automatically and progressively in proportion as the flow of air increases. The signal generator may comprise a threshold sensing device for the charge on a condenser fed by switch means controlled by the rotary member. The signal generator may comprise a computing device operated by pulses controlled by the rotary member.

15 Claims, 7 Drawing Figures

Fig. 1.

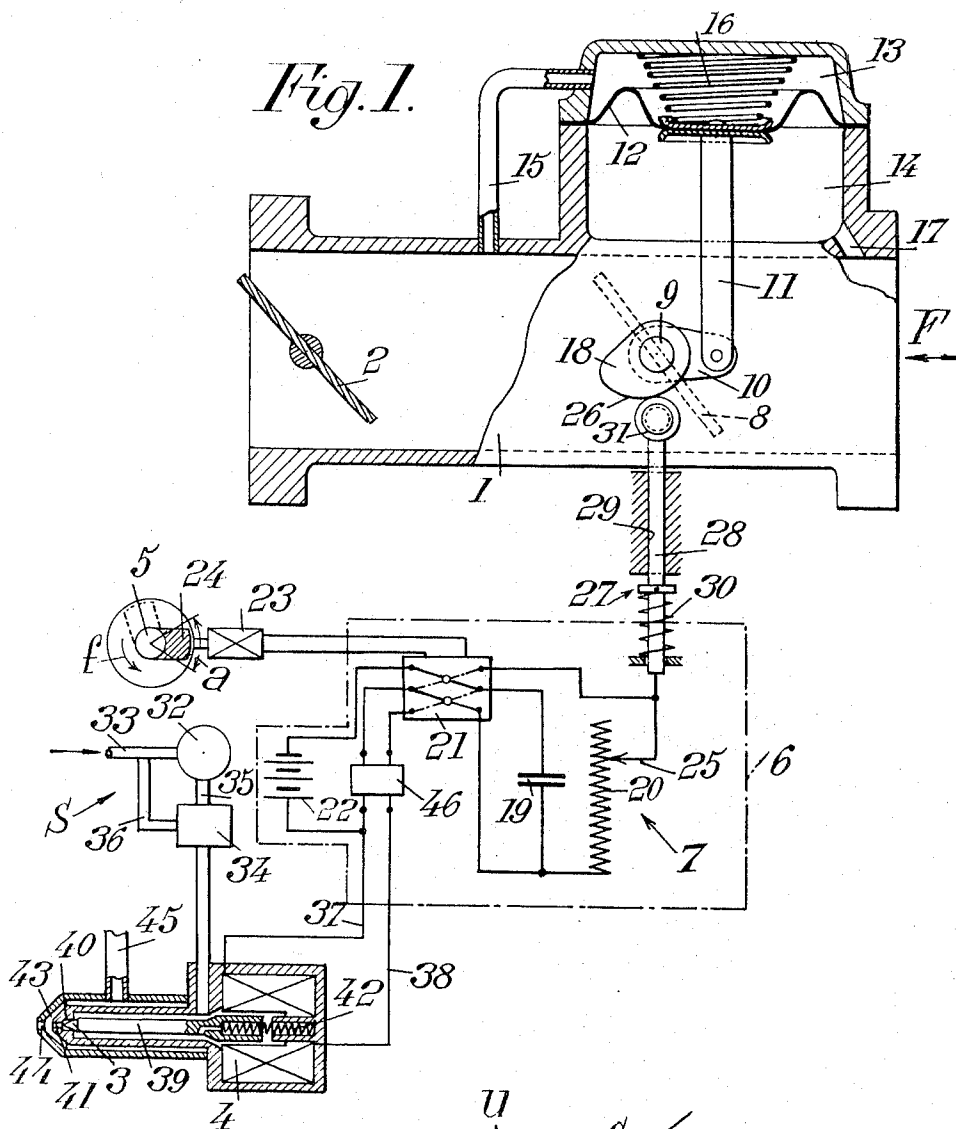
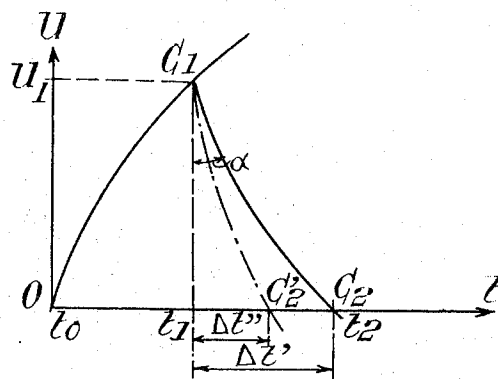


Fig. 2.



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Fig. 3.

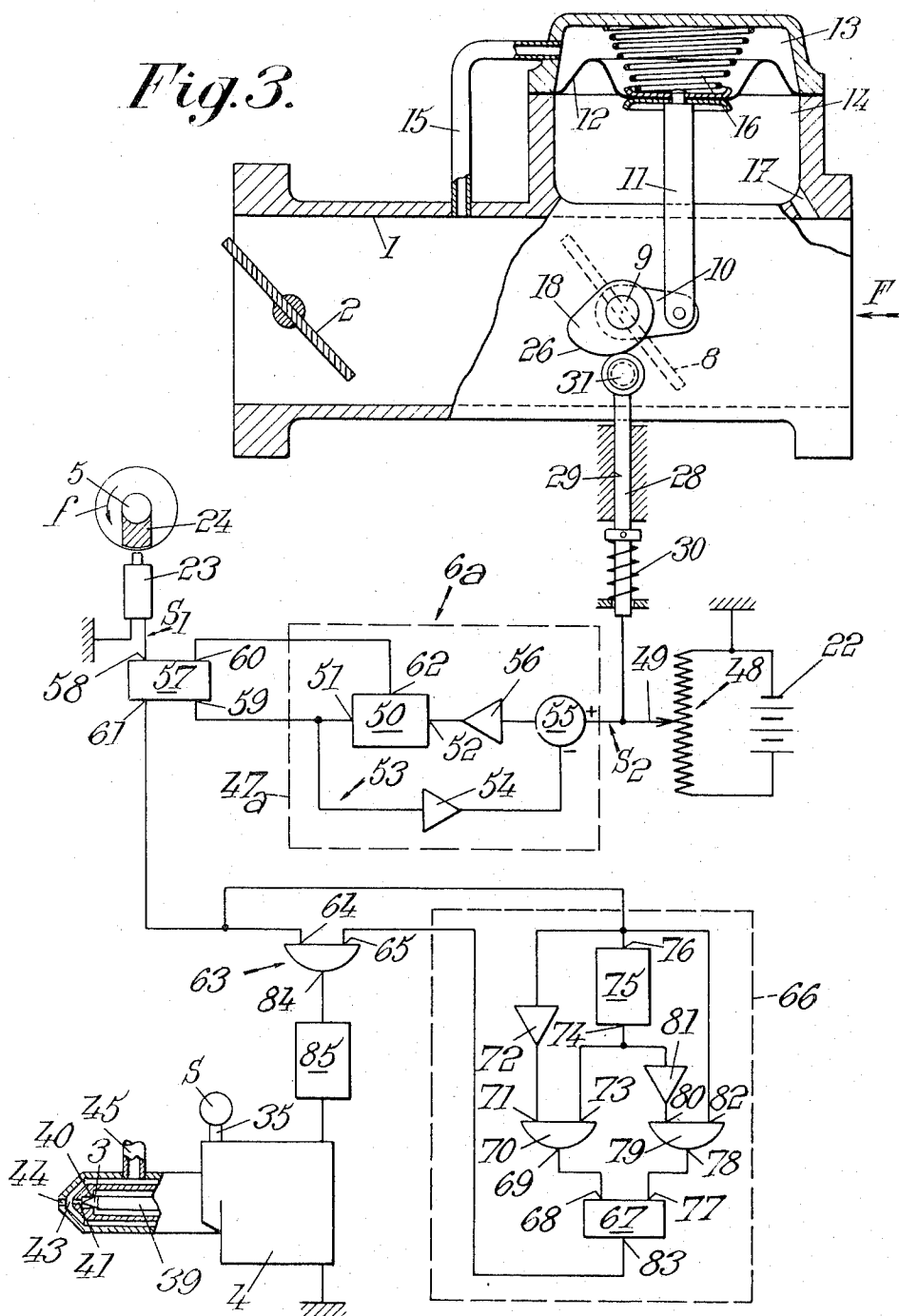


Fig. 4.

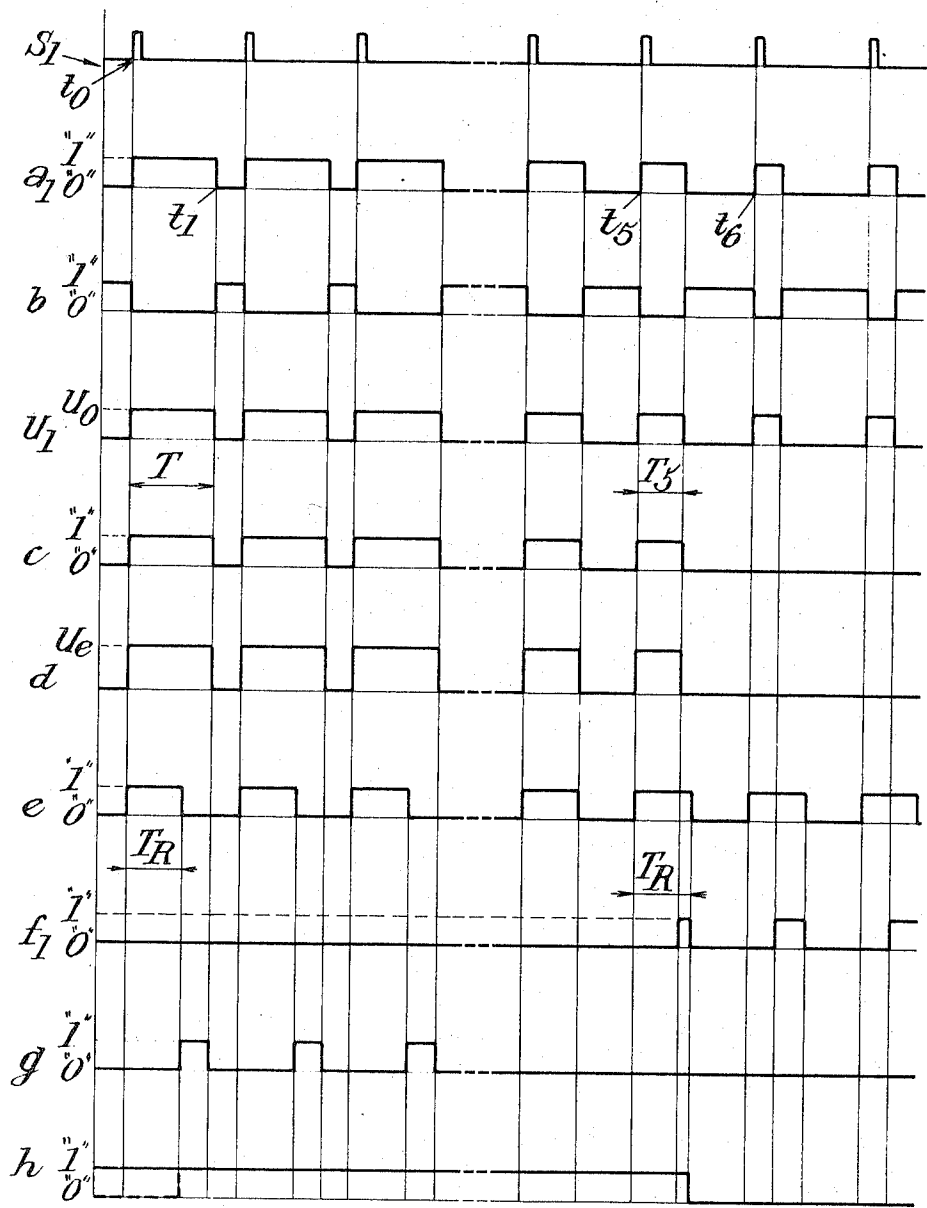


Fig. 5.

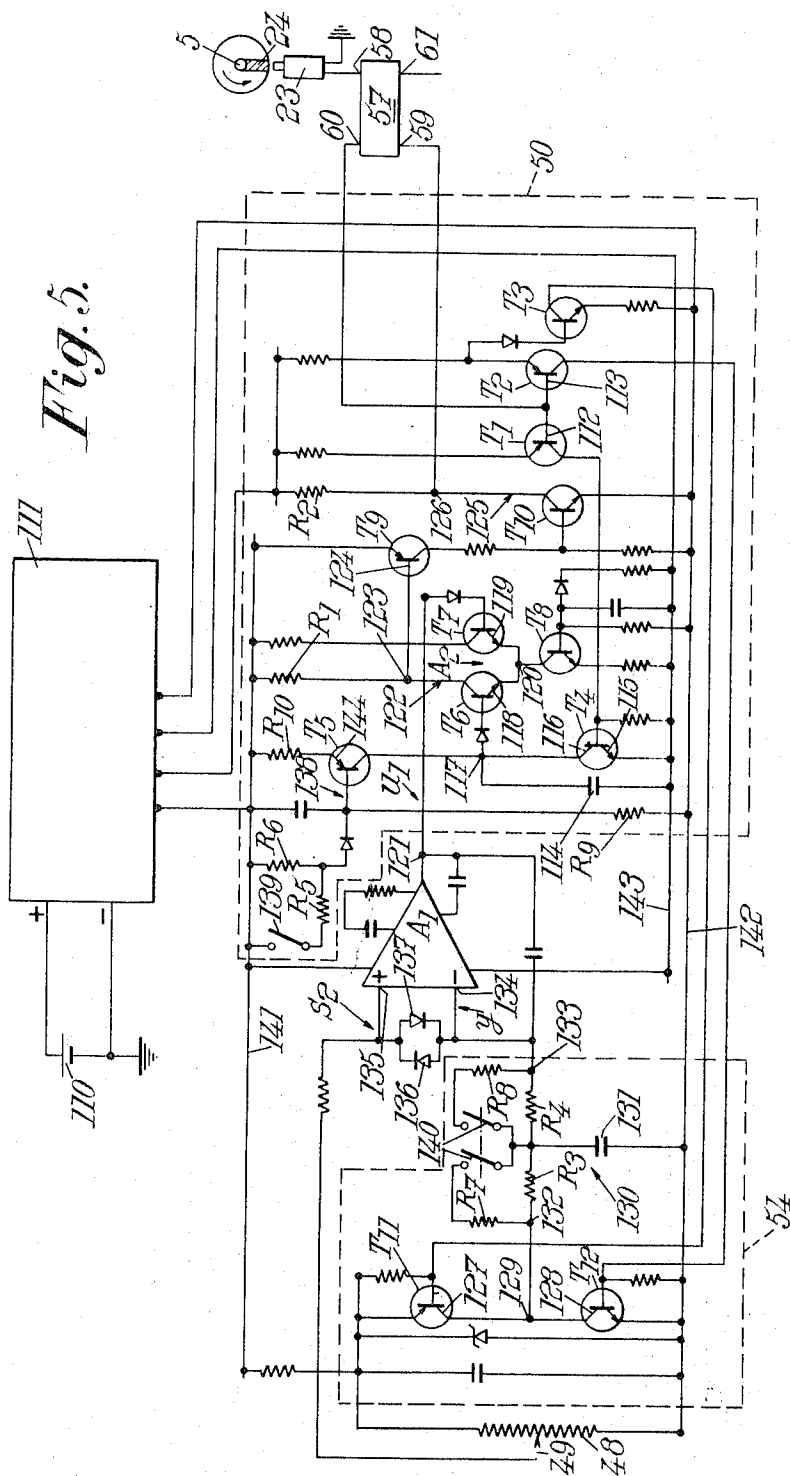


Fig. 6.

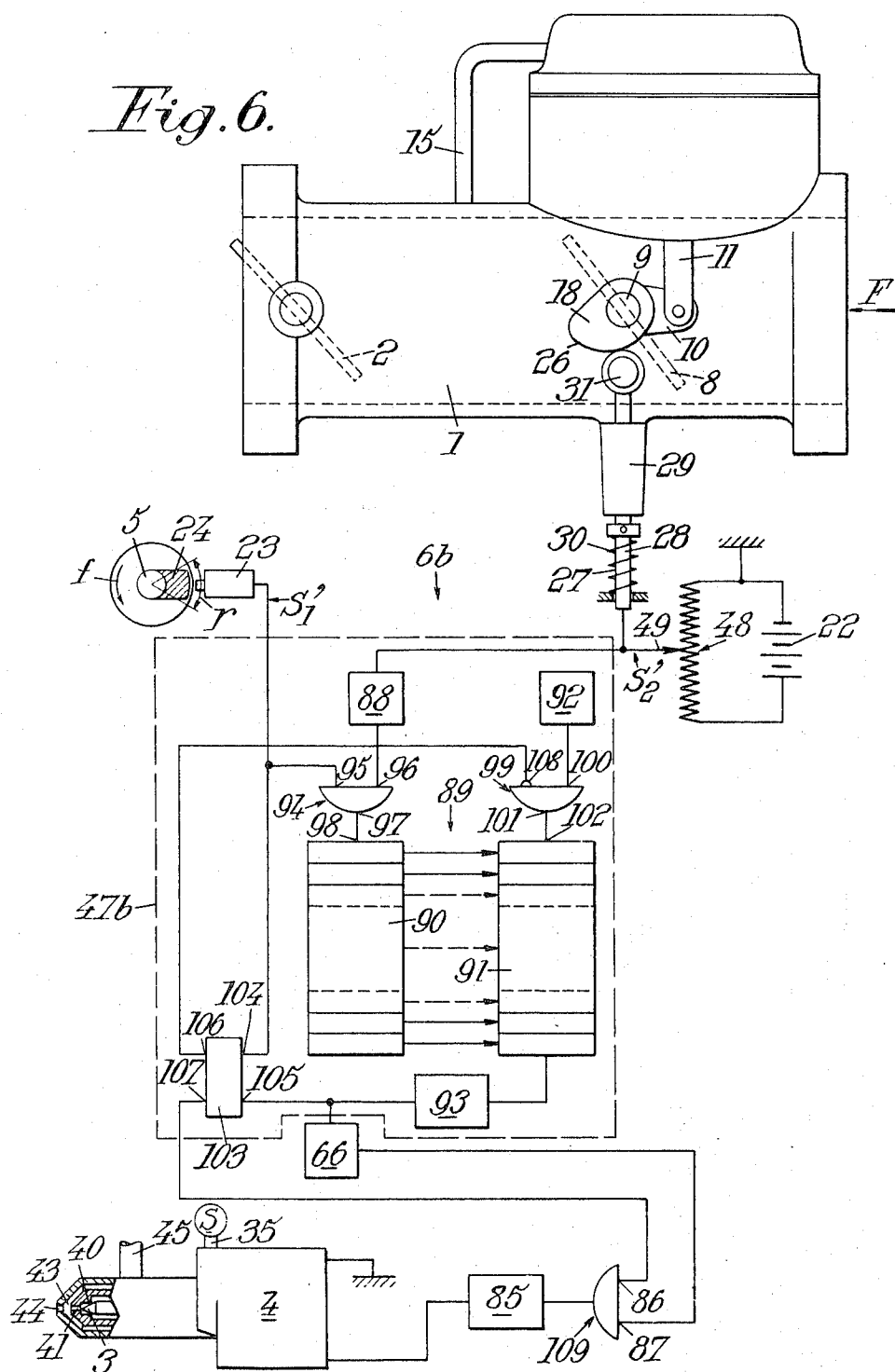
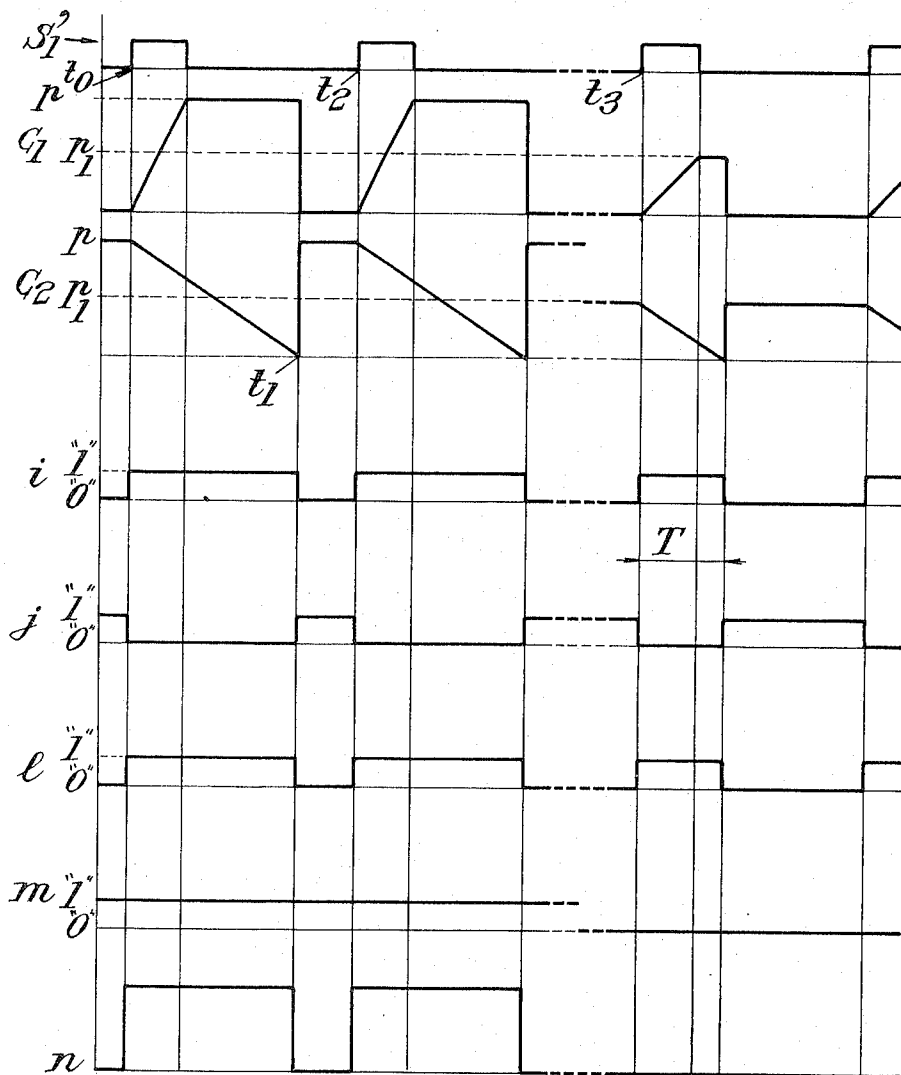


Fig. 7.



FUEL FEED DEVICES FOR INTERNAL COMBUSTION ENGINES

This is a continuation of application Ser. No. 10,420, filed Feb. 11, 1970, now abandoned.

The present invention relates to fuel feed devices, for internal combustion engines, of the type comprising, on one hand, in their intake pipe, a main throttle member actuated by the driver, on the other hand, a source of fuel under pressure, whose delivery circuit, which opens into the portion of the intake pipe situated downstream of the main throttle member, is controlled by at least one valve actuated by an electromagnet and, on the other hand finally, a metering system which, provided with a rotary member driven in continuous rotation, is adapted to send into this electromagnet at least one energising signal during a fraction of each turn of the said rotary member which is regulated by this system.

It is known that the regulation of this fraction of a turn determines, in a given interval of time, the total duration of opening of the valve and, consequently, the flow of fuel injected in the intake pipe during the said interval of time.

Feed devices are known (such as those described in British patent application No. 48,076/68 filed Oct. 10, 1968), in which the adjustment of this fraction of a turn is obtained by mechanical means controlled by a member sensitive to the flow of air in said pipe, that is to say to the flow of air by weight per unit time consumed by the engine.

However these devices are relatively bulky and impose on the whole of the rotary member, the member sensitive to the flow of air and the mechanical means which connect them, a volume and a positioning often difficult to ensure in practice.

It is a particular object of the invention to overcome the above-mentioned drawbacks and to render these feed devices such that they comply better than up to the present to the various desiderata of practice.

To this end, the feed device according to the invention comprises a signal generator adapted to employ, on each turn of said rotary member, a release signal which lasts during a predetermined and constant fraction of a turn of said rotary member, to produce an energising signal whose duration varies in the same sense as that of the release signal and in the same sense as the degree of opening of an auxiliary throttle member which is arranged in the intake pipe upstream of the main throttle member and which is arranged to be opened automatically and progressively in proportion as the flow of air in said pipe increases, the assembly being such that the fraction of each turn of said rotary member during which the energising signal is sent into the electromagnet varies in the same sense as the degree of opening of the auxiliary throttle member.

This signal generator may be constituted in numerous ways by making it comprise for example an element, preferably of variable impedance, sensitive to the position of the said auxiliary throttle member and having an influence on the duration of the energising signals supplied by the signal generator.

In a preferred embodiment, the said signal generator comprises a condenser, a variable resistance or rheostat and switch means adapted to actuate successively, and on each turn of the rotary member, the charge of the said condenser during the rotation of a predeter-

mined angle of this rotary member and the discharge of this condenser into a circuit constituted by the variable resistance and by a threshold device connected in series, the threshold device sending into the electromagnet an energising signal as long as the discharge current is greater than a given threshold.

The switch means have advantageously two stable states, a first state corresponding to the charging of the condenser and a second state corresponding to the discharge of the said condenser, these means being actuated by a signal furnished by a field sensor in the neighbourhood of which is rotated a magnetic mass rigidly fixed to the said rotary member, a rotation through a predetermined angle of the magnetic mass generating in the sensor, on each turn of this rotary member, a release signal of which the beginning actuates the placing into the first state of the said switch means and of which the end actuates the placing into the second state of the said switch means.

Variable resistance is advantageously constituted by a rheostat provided with a movable slider whose displacements are actuated by the movements of a cam which is rigidly fixed to the auxiliary throttling member and which comprises an active surface bearing on a mechanical connecting member movable with the said slider.

According to another feature of the invention, the feed device is, mainly, characterized by the fact that the above-said signal generator comprises a computing device adapted to supply the said energising signal from, on one hand, a first signal which represents the measure of the duration during which the said rotary member effects a rotation through a certain angle and which is constituted by the said release signal and, on the other hand, by a second signal which represents the measure of the degree of opening of the auxiliary throttling member.

In a preferred embodiment with the last-mentioned feature, the feed device in which the said first signal is constituted, on each turn of the rotary member, by a release pulse whose beginning is concomitant with the passage of the said rotary member through a fixed and predetermined angular position and the said second signal is constituted by a continuous voltage whose value depends on the degree of opening of the auxiliary throttling member, is characterized by the fact that the computing device includes a modulating member adapted to furnish, when it is placed in action by the start of a release pulse, an output voltage during a duration comprising a constant term and a term proportional to the value of input voltage furnished to the said modulating member, the output of the said modulating member being connected to its input through a loop in which are successively arranged, in series, an integrator adapted to integrate the output voltage during an interval of time comprised between the beginnings of two successive release pulses, a comparator adapted to effect the difference between the output signal of the integrator and the said second signal and a high gain amplifier adapted to transmit this amplified difference to the input of the modulating member, the energising signal being constituted by the output voltage of said modulating member.

According to another advantageous embodiment of the said improvement, a feed device in which the said first signal is constituted, on each turn of the rotary member, by a release pulse of which the duration is

proportional to the duration during which the said rotary member effects a rotation of a predetermined and constant angle and the said second signal is constituted by a continuous voltage whose value depends on the degree of opening of the auxiliary throttle member, is characterized by the fact that the computing device comprises an oscillator adapted to deliver pulses with a frequency depending on the value of the said second signal and read-in and read-out means adapted, on each release pulse, on one hand to read-in the number of pulses delivered by the said oscillator during the duration of the release pulse and, on the other hand, the read-out with a given and constant rhythm the number of pulses delivered by the said oscillator during the duration of the preceding release pulse, these read-in and read-out means furnishing, on each reading-out, a signal whose duration is proportional to the magnitude of the number of pulses read-out and which constitute the energising signal.

In order that the invention may be more fully understood, three embodiments of the fuel feed device according to the invention are described below, purely by way of illustrative but non-limiting examples, with reference to the accompanying drawings, in which:

FIG. 1 shows diagrammatically portions in elevation and portions removed, of a first embodiment of a fuel feed device according to the invention;

FIG. 2 shows, as a function of time, the charging and discharging curves of the condenser forming a part of the embodiment of FIG. 1.

FIG. 3 shows diagrammatically, with portions in elevation and portions removed, a second embodiment of a fuel feed device according to the invention;

FIG. 4 shows a table of curves illustrating the operation of the computing device of the embodiment shown in FIG. 3;

FIG. 5 shows in detailed manner a portion of the signal generator of the embodiment of FIG. 3;

FIG. 6 shows diagrammatically, with portions in elevation and portions removed, a third embodiment of the device according to the invention; and

FIG. 7, finally, shows a table of curves illustrating the operation of the computing device of the embodiment of FIG. 6.

According to the invention and more particularly according to that of its methods of application, as well as those of its methods of production of its various parts, to which it would appear that preference should be given and with a view to manufacturing a fuel feed device for a vehicle or a similar engine, the procedure is as follows or in analogous manner.

This device comprises, as shown in FIG. 1, 3 and 6: on one hand, in its intake pipe 1, a main throttle member (or butterfly valve) 2 actuated by the driver; on the other hand, a source S of fuel under pressure whose delivery circuit, which opens into the portion of the intake pipe 1 situated downstream of the main throttling member 2, is controlled by at least one valve 3 actuated by an electromagnet 4;

on the other hand, finally, a metering system which, provided with a rotary member 5 rotated continuously (in the direction of the arrow *f* of FIGS. 1, 3 and 6) is adapted to send into this electromagnet 4 an energising signal during a fraction of each turn of said member 5 which is regulated by this system.

This feed device comprises further, according to the invention, a signal generator 6 (FIG. 1), 6a (FIG. 3) or

6b (FIG. 6) adapted to apply, on each turn of the said rotary member 5, a release signal which lasts during a predetermined and constant fraction of a turn of the said rotary member 5, to produce an energising signal whose duration varies in the same sense as that of the release signal and in the same sense as the degree of opening of an auxiliary throttle member 8 which is arranged in the intake pipe 1 upstream of the main throttle member 2 and which is arranged to be opened automatically and progressively in proportion as the flow of air in said pipe 1 increases, the assembly being such that the fraction of each turn of said rotary member 5 during which the energising signal is sent into the electromagnet 4 varies in the same sense as the degree of opening of the auxiliary throttle member 8.

In the embodiments of FIGS. 1, 3 and 6 (FIG. 6 being simplified with respect to the others), the auxiliary throttle member 8 is constituted, for example, by a butterfly valve borne by an axle 9 on which is keyed a lever 10 (situated outside the pipe 1) at the free end of which is hinged a tie-rod 11 actuated by a pneumatic device. This pneumatic device comprises, for example, a diaphragm 12 which is connected to the tie-rod 11 and which separates two chambers 13 and 14 from one another. A pipe 15 places the chamber 13 in communication with the section of the pipe 1 which is included between the throttle members 2 and 8. A spring 16 tends to push the diaphragm 12 and the tie-rod 11 downward in FIGS. 1, 3 and 6 hence to close the valve 8, against the action of the pressure transmitted through the pipe 15 and acting on said diaphragm 12. The chamber 14 is placed at atmospheric pressure through a channel 17 which opens preferably into the intake of the pipe 1, between an air filter (not shown) and the valve 8. Finally, a cam 18 is keyed on the axle 9, outside the pipe 1.

It is seen that the angular position of the auxiliary throttle member 8 or that of the axle 9 at any moment corresponds to the flow of air (flow of air by weight in unit time consumed by the engine) which flows in pipe 1 in the direction of the arrow F.

The greater the flow of air, the greater the degree of opening of the valve 8, a substantially constant suction (or varying according to the characteristics of the spring 16) is established between the two throttle members 2 and 8.

The auxiliary throttle member 8 could be replaced by well-known engineering equivalents, such as those described in British patent application No. 48,076/68 filed Oct. 10, 1968.

In the first embodiment shown in FIG. 1, the signal generator 6 may be constituted by making it include an element 7, preferably a variable impedance, sensitive to the position of the said auxiliary throttle member 8 and having an influence on the duration of the energising signals furnished by the said generator.

In the embodiment of FIG. 1, the signal generator 6 is constituted by making it include a condenser 19, a variable resistance or rheostat 20 and changeover switch means 21 adapted to actuate successively, on each turn of the member 5, the charging of the condenser 19 during the rotation of a predetermined and constant angle α of this member 5 and the discharge of this condenser 19 into a circuit constituted by the variable resistance 20 and a threshold device 46 connected in series, this threshold device 46 sending into the elec-

tromagnet 4 an energising signal as long as the discharge current is greater than a given threshold.

The said switch means 21 (which are shown in diagrammatic manner in FIG. 1) are advantageously with two stable states, a first state (effected through the connections in full lines) corresponding to the charging of the condenser 19 through a battery 22 and a second state (effected through the connections in mixed lines) corresponding to the discharge of the condenser 19, these means 21 being controlled by a release signal furnished by a field sensor 23 in the vicinity of which is rotated a magnetic mass 24 rigidly fixed to the rotary member 5. Rotation through a predetermined angle α of the magnetic mass 24 generates, in the sensor 23, on each turn of the member 5, a release signal whose start actuates the placing in the first state of the said switch means 21 and of which the end actuates the placing in the second state of the said switch means 21. These switch means 21 as well as the threshold device 46, known in themselves, may be formed by means of relays.

The variable resistance 20 is advantageously constituted by a rheostat provided with a movable slider 25 whose displacements are controlled by the movements of the cam 18 which is rigidly fixed to the auxiliary throttle member 8 and which comprises an active surface 26 bearing on a mechanical connecting member 27 movable with the said slider 25.

The abovesaid mechanical connecting member 27 is constituted by a rod 28 which can slide in a guide 29 and which is supported under the action of a spring 30 against the active surface 26 of the cam 18, through a roller 31.

The speed of rotation of the rotary member 5 (constituted for example and as shown in FIG. 1 by an axle) not having influence on the overall duration of opening of the valve 3 since this duration only depends on the fraction of each turn of the said member during which the said valve is open, the member 5 can be driven for example by a constant speed electric motor.

However, if it is desired to cycle the injection of fuel, that is to say to determine at which moment of each engine cycle the fuel injection is made into the stream of air flowing in the pipe 1, it is preferable to drive the member 5 through the shaft of the internal combustion engine, by a transmission imposing on it a speed of rotation preferably a multiple of that of this shaft.

As regards the source of fuel S, it is preferably constituted, according to the three embodiments of FIGS. 1, 3 and 6, by the assembly of a pump 32 (FIG. 1) which pumps the fuel into a reservoir (not shown) through a suction channel 33 and a pressure regulator 34 arranged on the supply channel 35 of the pump. This regulator, known in itself, is adapted to place into communication the channels 33 and 35 through an evacuation channel 36 as soon as the pressure in the channel 35 exceeds a predetermined value.

As regards the delivery circuit, the electromagnet 4, whose supply is ensured by conductors 37, 38 connected to the threshold device 46, actuates a rod 39 whose end, forming the valve 3, co-operates with a seat 40 connected to a delivery channel 35, the seat 40 ending at a calibrated orifice 41 which opens into the pipe 1 (for reasons of clarity, this arrangement of the calibrated orifice 41 with respect to the pipe 1 is not shown in FIGS. 1, 3 and 6).

A spring 42 tends constantly to close the valve 3 whilst, when it is energised, the electromagnet 4 opens this valve. It is advantageous to shield the injection orifice 41 from the influence of the suction existing in the pipe 1 downstream of the main throttle member 2. To this end, the orifice 41 is made to open into a chamber 43 communicating with the pipe 1 through an orifice 44 which is preferably aligned with the orifice 41 and whose section is preferably greater than that of this latter orifice and the chamber 43 is connected to an aerating zone at substantially constant pressure through a channel 45 whose cross-section is distinctly greater than that of orifice 44.

The feed device shown in FIG. 1 operates as follows.

On each turn of the member 5, the magnetic mass 24 passing in front of the sensor 23 causes, during a certain angle of rotation (or fraction of a turn) α , the emission by the sensor 23 of a release signal whose beginning actuates the charging of the condenser 19 and whose end actuates the discharge of this condenser 19 into the variable resistance 20 and into the threshold device 46, which actuates the opening of the valve 3 and hence the injection of fuel as long as the discharge current exceeds a determined threshold.

The operation of the signal generator is illustrated by FIG. 2 in which are shown as abscissae the time t and as ordinate the voltage U at the terminals of the condenser 19.

Assuming that during the interval of time comprised between the moments t_0 and t_1 , the magnetic mass 24 turns through an angle α in front of the sensor 23. The condenser 19 is then charged by the battery 22 and the voltage U of this condenser increases along the curve OC_1 .

When the mass 24 emerges from the limits of the angle α , at the moment t_1 , the condenser 19 has acquired a charge U_1 whose value is substantially proportional to the interval of time $\Delta t = t_1 - t_0$ and consequently substantially inversely proportional to the number of turns per second of the mass 24.

At the instant t_1 , the end of the release signal emerging from the sensor 23 actuates the discharge of the condenser 19 whose voltage U decreases along the curve C_1C_2 which reaches at the moment t_2 the value for which the electromagnet 4 ceases to maintain the opening of the valve 3, this valve being then closed under the action of the spring 42.

The fraction of a turn G of the mass 24 during which the condenser 19 is discharged and during which the valve 3 is open is expressed by the product:

$$G = (t_2 - t_1) \cdot N - \Delta t' \cdot N \quad (1)$$

N being the number of turns per second of the mass 24 and $\Delta t'$ the interval of time separating the moments t_2 and t_1 .

If the curves OC_1 and C_1C_2 are compared with straight lines and if the angle between the curve C_1C_2 and the vertical passing through C_1 is called α , then:

$$\Delta t' = U_1 \operatorname{tg} \alpha \quad (2)$$

U_1 being considered as the measure of the segment OU_1 on the axis OU and $\Delta t'$ as the measure of the segment t_1t_2 on Ot .

Moreover, U_1 is substantially proportional to $1/N$, or:

$$U_1 = k/N \quad (3)$$

By combining (1), (2) and (3), there is obtained:

$$G = (k/N) \cdot \operatorname{tg} \alpha \cdot N = k \operatorname{tg} \alpha$$

It is deduced therefrom that the fraction of a turn of the mass 24 during which the valve 3 is open only depends on the value of the angle α .

The value of the angle α is determined, in the embodiment of FIG. 1, by the value of the variable resistance 20, which is controlled by the movements of the cam 18 so that said fraction of a turn varies in the same sense as the degree of opening of the auxiliary throttle member 8.

By successive experiments, the active surface 26 of the cam 18 can be given a shape such that the said fraction of a turn is for example proportional to the flow of air in the pipe 1.

In FIG. 2, there is shown a discharge curve C_1C_2' corresponding to a flow of air less than in the case of the curve C_1C_2 , the time of injection $\Delta t''$ being also less than the time $\Delta t'$.

It is self-evident that the embodiment of the fuel feed device which has been described above is only one simple example and that he could also include a cold starting system such as described in U.S. Pat. No. 3608533.

In addition, it may be advantageous to arrange the pressure regulator 34 of the source S according to the arrangements in British patent application No. 48,076/68 of Oct. 10, 1968, so that this regulator fixes in the delivery channel 35 a pressure proportional to the air pressure existing in the section of the pipe 1 situated between the throttle members 2 and 8 in order to adapt the fuel flow to the conditions of acceleration.

Moreover, the rotary member 5 may advantageously be a member existing already in the engine, as for example the ignition distributor on which it is easy to fix a rotary magnetic mass 24 turning in the vicinity of a sensor 23.

It may also be noted that the rotary member does not necessarily have to be driven by the internal combustion engine and that it can hence be separated from the latter.

In the embodiments shown in FIGS. 3 to 6, the signal generator 6a (FIG. 3) or 6b (FIG. 6) comprises a computing device 47a (FIG. 3) or 47b (FIG. 6) adapted to furnish the above-defined energising signal starting, on one hand, from a first signal S_1 (FIG. 3) or S_1' (FIG. 6) which represents the measurement of the duration during which the said turning member 5 effects a rotation of a certain angle and which is constituted by the abovesaid release signal and, on the other hand, by a second signal S_2 (FIG. 3) or S_2' (FIG. 6) which represents the measurement of the degree of opening of the auxiliary throttle member 8.

In the case of the feed device of FIG. 3, the first signal S_1 (which is represented as a function of the time by a curve denoted by S_1 in the table of FIG. 4) is constituted, on each turn of the rotary member 5, by a pulse which is emitted by the field sensor 23, the beginning of the pulse being concomitant with the passage of the magnetic mass 24 in front of the sensor 23 (position shown in FIG. 3). The interval of time separating the beginnings of two successive pulses of the signal S_1 represents the measurement of the duration during which the rotary member 5 effects a rotation through an angle of 360° .

The second signal S_2 is obtained, like signal S_2' of the device of FIG. 6, by a potentiometer 48 which is fed by the voltage source 22.

This potentiometer includes a movable slider 49 (on which is collected the signal S_2 or S_2') whose displacement

are controlled like those of the slider 25 of the embodiment of FIG. 1.

The computing device 47a of the embodiment of FIG. 3 comprises advantageously a modulating member 50 adapted to supply, when it is placed in action by the start of a pulse of the first signal S_1 , an output voltage U_1 during a time T comprising a constant period T_0 and a period $k \cdot u_1$ proportional to the value of the input voltage u_1 furnished to the said modulating member 50, the output 51 of the said modulating member 50 being connected to its input 52 through a loop 53 in which are successively arranged, in series, an integrator 54 adapted to integrate the output voltage U_1 during an interval of time comprised between the commencements of two successive pulses of the first signal S_1 , a comparator 55 adapted to effect the difference between the signal emerging from the integrator 54 and the second signal S_2 and a high gain amplifier 56 G adapted to transmit this amplified difference to the input 52 of the modulating member 50, the energising signal being constituted by the output voltage U_1 of the modulating member 50.

In a preferred embodiment, the signal generator 6a comprises a flip flop 57 with two control inputs 58 and 59 and two outputs 60 and 61.

The first input 58 is fed by the first signal S_1 , the second input 59 is fed by the output voltage U_1 of the modulating member 50, the first output 60 being connected to an input 62 for placing in action the modulating member 50 and the second output 61 is adapted to furnish an energising signal.

An energising signal is present at the second output 61 each time that the flip flop 57 is placed in a state whose beginning is controlled by the beginning of a pulse of the signal S_1 (this state controlling through the output 60 and the input 62 the beginning of the output voltage U_1 supplied by the modulating member 50) and whose end is controlled by the end of the output voltage U_1 .

In another advantageous arrangement, the energising signals are transmitted to the electromagnet 4 through an electronic switch 63 which is constituted by an AND gate of which one input 64 receives the energising signals and of which the other input 65 is adapted to be fed by the comparison means 66.

These comparison means 66 are adapted to compare the period T of each energising signal with a corresponding fixed reference T_R , preferably, with the period of the energising signal when the internal combustion engine of the vehicle is on idling and to control the opening or the closing of an AND gate 63 so that the transmission of the energising signals to the electromagnet 4 is ensured when the duration of the said energising signal is greater than the period T_R and that the transmission of the energising signals of the electromagnet 4 is interrupted when the period of the said energising signal is less than the period T_R .

These comparison means 66 include advantageously a flip flop 67 of which a first control input 68 is connected to the output 69 of an AND gate of which one input 71 is fed, through an inverter 72, by energising signals emerging from the output 61 of the flip flop 57. The other input 73 of the AND gate 70 is connected to the output 74 of a monostable flip flop 75 whose input 76 is supplied by the said energising signals. The second control input 77 of the flip flop 67 is connected to the output 78 of an AND gate 79 of which one input 80 is

connected, through an inverter 81, to the output 74 of the flip flop 75 and whose other input 82 is fed by the energising signals.

The monostable flip flop 75 delivers pulses of which the beginning coincides with the beginning of the energising signals and of which the period is equal to T_R . The bistable flip flop 67 feeds through its output 83 and the input 65 of the AND gate 63 so that, when the said flip flop 67 occupies a first state which is controlled by one or more of the pulses sent into its input 68, the AND gate 63 interrupts the transmission of the energising signals and that, when the said flip flop 67 occupies a second state which is controlled by one or more of the pulses sent into its input 77, the AND gate 63 ensures the transmission of the energising signals.

The energising signals present at the output 84 of the AND gate 63 are advantageously applied to the electromagnet 4 by a power relay 85.

The operation of the embodiment of the feed device of FIG. 3 will now be described with the aid of the table of FIG. 4.

In this table, there is shown as a function of time the first signal S_1 , the signal a_1 present at the output 61 of the flip flop 57, the signal b present at the output 60 of the flip flop 57, the output voltage U_1 of the modulating member 50, the signal c present at the output 84 of the AND gate 63, the signal d supplied by the relay 85 to the electromagnet 4, the signal e present at the output 74 of the monostable flip flop 75, the signal f_1 present at the output 69 of the AND gate 70, the signal g present at the output 78 of the AND gate 79 and the signal h present at the input 65 of the AND gate 63.

It is assumed that at the moment t_0 , a pulse of the first signal S_1 arrives at the input 58 of the flip flop 57. This pulse controls a change of state of the flip flop 57 on the output 61 of which appears a signal a_1 of value "1" as shown by the table of FIG. 4. At the same time, there appears on the output 60 a signal b of value "0" and the descending front of this signal b actuates the placing in operation of the modulating member 50 which supplies on its output 51 an output voltage U_1 of which it is assumed that it has a constant amplitude and equal to U_0 . This voltage U_1 has, thus as has already been explained, a duration T which may be expressed by:

$$T = T_0 + k u_1$$

and of which it will be seen below that it corresponds well to the conditions of duration of the energising signal.

At the moment t_1 which marks the end of the output voltage U_1 , the descending front of the said output voltage U_1 actuates the change of state of the flip flop 57, the signal a_1 taking the value "0" and the signal b taking the value "1".

The signal a_1 , of which the duration in the state "1", is equal to the duration of the output voltage U_1 , is sent onto the input 64 of the AND gate 63 and, if the input 65 of the said AND gate 63 is fed by a signal h of value "1", the AND gate 63 transmits onto its output 84 a signal c analogous to the signal a_1 .

The cycle described above is reproduced on each release pulse of the signal S_1 and the relay 85 thus supplies, on each pulse of the signal S_1 and hence on each turn of the rotary member 5, an energising signal of which the amplitude is for example equal to U_e and of which the duration is equal to T (signal d).

The signal e shows the pulses of duration T_R which are present at the output 74 of the monostable flip flop

75 and of which the beginnings are concomitant with the beginnings of the output voltages U_1 . In the case where T is greater than T_R , to each output voltage U_1 there corresponds a pulse (signal g) which is applied on the input 77 of the bistable flip flop 67 and which places or holds this flip flop 67 in a state for which a signal h of value "1" is present on its output 83. The AND gate 63 therefore transmits the energising signals.

In the case where T is less than T_R , to each output voltage U_1 corresponds a pulse (signal f_1) which is applied on the input 68 of the bistable flip flop 67 and which places or holds this flip flop 67 in a state for which a signal h of value "0" is present on its output 83. The AND gate 63 then interrupts the transmission of energising signals.

Thus, in the table of FIG. 4, the three first energising signals have a duration T greater than T_R and the AND gate 63 transmits them to the relay 85 which supplies a signal d .

The fifth energising signal, of which the beginning intervenes at the moment t_5 , has a duration T_5 less than the duration T_R (as a result of modification of the degree of opening of the auxiliary throttle member 8) and the pulse (signal f_1) which results therefrom, causes the signal h to pass from the value "1" to the value "0", which interrupts the transmission of the sixth energising signal, intervening at the moment t_6 , through the AND gate 63.

As regards the computing device 47a, the signal S_2 has a value:

$$S_2 = U_0 f(\alpha) \quad (4)$$

U_0 (chosen as equal, for reasons of simplification, as the amplitude U_0 of the output voltage U_1) being the voltage of the source 22 and $f(\alpha)$ a function of which the value varies in the same sense as the air flow α .

The comparator 55 delivers a voltage:

$$\epsilon = S_2 - y \quad (5)$$

y being the output voltage of the integrator 54.

The amplifier 56 of high gain G delivers a voltage:

$$u_1 = G \cdot \epsilon \quad (6)$$

The modulating member 50 produces, on each pulse of the signal S_1 , a voltage U_1 , of which the amplitude is U_0 and of which the duration is:

$$T = T_0 + k \cdot u_1 \quad (7)$$

The period τ of the pulses of the first signal S_1 is:

$$\tau = k_1/N \quad (8)$$

N being the number of turns per second of the rotary member 5.

The integrator 54 supplies a voltage y which represents the average value of the actuating voltage U_1 between two pulses of the signal S_1 ; thus:

$$y = U_0(T/\tau) \quad (9)$$

By combining the equations (1) to (6), one obtains:

$$T = T_0 + k \cdot G \cdot U_0 [(S_2/U_0) - (T/N/k_1)] \quad (10)$$

namely:

$$T = T_0/[1 + kGU_0(N/k_1)] + KGU_0/[1 + kGU_0(N/k_1)] \cdot (S_2/U_0) \quad (11)$$

G being very large, one obtains: $T = (k_1/N) \cdot (S_2/U_0)$

namely:

$$T = (k_1/N) \cdot f(\alpha) \quad (12)$$

As a result the fraction T/N of each turn of the rotary member 5 during which the energising signal is sent to the electromagnet 4 and during which the valve 3 permits the injection of fuel into pipe 1 depends only on the degree of opening of the auxiliary throttle member 8.

The function $f(\alpha)$ depends on the shape of the active surface 26 of the cam 18 and, by successive experiments, there can be given to this active surface 26 a shape such that the function $f(\alpha)$ and the fraction of a turn concerned have values for example proportional to the flow of air in pipe 1.

FIG. 5 shows in detail an embodiment of the computing device 47a forming part of the signal generator 6a already described.

This computing device 47a, which is supplied by a battery 110 and through a static converter 111, comprises the same elements as the computing device 47a of FIG. 3, namely a modulating member 50, an integrator 54, a comparator 55 and an amplifier 56, constituted by a differential amplifier A_1 producing both the comparison between the second signal S_2 emerging from the potentiometer 48 and the signal y emerging from the integrator 54 and the amplification of the difference ϵ between S_2 and y .

The modulating member 50 comprises p-n-p transistors T_1 and T_2 which are connected through their bases 112 and 113 to the output 60 of the flip flop 57 and which control respectively n-p-n transistors T_4 and T_3 . A condenser 114 is connected with the emitter 115 and the collector 116 of the transistor T_4 and a p-n-p transistor T_5 , which is mounted in the current source, supplies the junction 117 between the collector 116 of the transistors T_4 and the condenser 114, with current.

The modulating member 50 comprises also a differential amplifier A_2 formed by n-p-n transistors T_6 and T_7 of which the emitters 118 and 119 are connected in parallel to the collector circuit 120 of an n-p-n transistor T_8 mounted in the current source. This differential amplifier A_2 is adapted to compare the voltage existing at the junction 117 with the voltage occurring at the output 121 of the differential amplifier A_1 .

In the collector circuit 122 of the transistor T_6 is arranged a resistance R_1 of which one terminal 123 is connected to the base 124 of a p-n-p transistor T_9 . This transistor T_9 controls an n-p-n transistor T_{10} in the collector circuit 125 of which is arranged a resistance R_2 of which one terminal 126 is connected to the input 59 of the flip flop 57.

The integrator 54 comprises two p.n.p. transistors T_{11} and T_{12} which are respectively controlled by the transistors T_3 and T_2 and of which the emitters 127 and 128 are connected to a junction 129. The integrator 54 comprises again a low-pass filter 130 which is formed by resistances R_3 and R_4 and a condenser 131. The input 132 of this filter is connected to the junction 129 and the output 133 of the said filter is connected to the negative input 134 of the differential amplifier A_1 . The positive input 135 of this amplifier A_1 is connected to the slider 49 of the potentiometer 48.

Between the inputs 134 and 135 of the amplifier A_1 are arranged diodes 136 and 137 mounted head-to-tail.

In the base circuit 138 of the transistor T_5 are mounted in parallel resistances R_5 and R_6 of which one (the resistance R_5) may be placed in or out of the circuit according to the position of change-over switch 139.

A second change-over switch 140, of which the position is controlled at the same time as that of the change-over switch 139, can, according to its position, place resistances R_7 and R_8 in parallel or not with the resistances R_3 and R_4 .

There will now be described the operation of this computing device 47a. Assuming that the input voltage u_1 is supplied to the modulating member 50 and that the transistors $T_1, T_2, T_4, T_5, T_7, T_8$ are in a conductive state whilst the transistors T_3, T_6, T_9 and T_{10} are in a blocked state.

At the moment to, a pulse of the first signal S_1 appears at the input 58 of the flip flop 57. This pulse actuates a change of state of the flip flop 57 on the output 61 of which appears the signal a_1 of value "1" as shown in the table of FIG. 4. At the same time there appears on the output 60 a signal b of value "0" which blocks the transistors T_1 and T_2 . The transistor T_2 puts into a conductive state the transistor T_3 and the transistor T_1 places in a blocked state the transistor T_4 . The constant current, which is provided by the transistor T_5 and which, before the moment to, passes through the transistor T_4 , then charges the condenser 114. When the voltage at the junction 117 becomes equal to the voltage u_1 at the output of the differential amplifier A_1 , the transistor T_6 of the differential amplifier A_2 becomes conductive and conducts a portion of the constant current supplied through the transistor T_8 , which places in a conductive state transistors T_9 and T_{10} . The drop in voltage caused at the terminal 126 of the resistance R_2 by the placing of the transistor T_{10} in a conductive state restores the flip flop 57 into the state that it had before the arrival at the moment to of a pulse of the first signal S_1 , the signal a_1 taking the value "0" and the signal b taking the value "1". The signal b of value "1" places the transistors T_1 and T_2 in a conductive state. The transistor T_1 places the transistor T_4 in a conductive state which enables a rapid discharge of the condenser 114 and the transistor T_2 places the transistor T_3 in a blocked state. The discharge of the condenser 114 brings about the placing in a blocked state of the transistor T_6 which controls the placing in a blocked state of transistors T_9 and T_{10} .

It is seen that it is thus reobtained the conditions fixed at the start and that the modulating member 50 is ready to effect the above-described operations on the arrival of a new pulse of the first signal S_1 .

As regards the duration T during which the flip flop 57 occupies a state for which the signal b has a value "1", which duration corresponds to that of the energising signal of the electromagnet 4 and which must be equal to $T = T_0 + ku_1$, it will now be verified that it corresponds well to the operation of the modulating member 50.

It will be assumed that the line 141 is at a supply voltage $+V$, that the line 142 is at a supply voltage $0V$, that the line 143 is at a supply voltage $-V$ and there will be taken into account the existence of a resistance R_9 connecting the base 138 of the transistor T_5 to the line 142 and of a resistance R_{10} connecting the emitter 144 of the transistor T_5 to the line 141.

The voltage V_{117} at the junction 117 depends on the charge of the condenser 114 and is expressed by $V_{117} = io/C_{114} \cdot t$ if io is the charging current supplied through the transistor T_5 .

Designating R_x as the equivalent resistance to resistances R_5 and R_6 , one has

$$io = V [R_x(R_x + R_9)] \cdot (1/R_{10})$$

By putting $R_y = R_{10} \cdot [(R_x + R_9)/R_x]$, one has

$$V_{117} = (Vt)/(R_y \cdot C_{114})$$

The duration T that the condenser 114 is charged so that the voltage V_{117} becomes equal to the voltage V_{121}

at the output 121 of the differential amplifier A_1 is given by:

$$V_{121} = V \cdot T / R_v C_{114}$$

Now, by taking V_{121} from the zero volt level, one has:

$$V_{121} = u_1 - (-V) = u_1 + V$$

There is thus obtained:

$$T = R_v C_{114} + R_v C_{114} (u_1 / V)$$

By comparison with the equation $T = T_0 + k u_1$ given above, there is obtained:

$$T_0 = R_v C_{114} \text{ and } k = R_v C_{114} / V$$

The modulating member 50 hence controls the change of state of the flip flop 57 after a duration comprising a constant period T_0 and a period $k u_1$ proportional to the value of the voltage u_1 .

Now as regards the integrator 54 which produces the voltage u_1 , it has been seen that the transistor T_3 was placed in a conductive state during the period T of each pulse of the energising signal. When it is in this conductive state, the transistor T_3 puts the transistor T_{11} in a conductive state and puts in its blocked state the transistor T_{12} and, when this transistor T_3 is in its blocked state, it puts the transistor T_{11} in its blocked state and the transistor T_{12} in its conductive state. Consequently, the junction 129 is placed at a potential in the neighbourhood of the supply voltage $+V$ for periods T and it is placed at a potential in the neighbourhood of the voltage $0V$ during the intervals of time separating the periods T . The low-pass filter 130 supplies to its output 133 an average value of the voltage existing at the junction 129, which average value varies in the same sense as the periods T and in a sense contrary to the intervals of time separating the two pulses of the first signal S_1 .

On starting the engine, it is convenient, on one hand, to increase the periods T of the energising signals, and on the other hand, to increase integration time constant of the low-pass filter 130.

To do this, resistances R_5 , R_7 and R_8 are placed out of circuit, on starting, by change-over switches 139 and 140 and are later placed in circuit.

The diodes 136 and 137 have the role of limiting the difference between the voltages u_1 and S_2 in order not to overload the amplifier A_1 .

Now as regards the feed device of FIG. 6, the first signal S_1' (which is shown as a function of time by a curve denoted by S_1' in the table of FIG. 7) is constituted, on each turn of the rotary member 5, by a release pulse which is emitted by the field sensor 23, the duration of each release pulse being proportional to the duration during which the said rotary member effects a rotation of a predetermined and constant angle r .

The second signal S_2' is similar to signal S_2 and is obtained by means analogous to those which have already been described with relation to the device of FIG. 3.

The computing device 47b of the device of FIG. 6 comprises advantageously an oscillator 88 (such as an overcoupled oscillator) adapted to deliver pulses with a frequency F_1 dependent on the value of the second signal S_2' and of reading in and reading out means adapted, on each release pulse of the first signal S_1' , on one hand, to read in the number of pulses delivered by the said oscillator 88 during the period of the release pulse and, on the other hand, to read out with a given and constant rhythm the number of pulses delivered by the said oscillator 88 during the period of the preceding release pulse, these reading in and reading out means providing, on each reading out, a signal of which the

duration is proportional to the magnitude of the number of pulses read out and which constitutes the energising signal.

According to a preferred embodiment, the reading in and reading out means comprise a totalisator 89 provided with a first memory 90 adapted to read in the number of pulses delivered by the oscillator 88 during the period of a release pulse and a second memory 91 adapted to record this number and to provide, under the action of a generation 92 of pulses read out at a fixed frequency F_2 , a signal constituted by a succession of this same number of read out pulses, the said succession of read out pulses being applied to a decoding member 93 adapted to furnish an output voltage constituting the energising signal during a period equal to that of the said succession of read out pulses.

These read in and read out means include again a first electronic switch 94 (constituted by an AND gate) of which one input 95 is supplied by the first signal S_1' , of which another input 96 is supplied by pulses furnished by the oscillator 88 and of which the output 97 is connected to the input 98 of the memory 90. The AND gate 94 transmits to the memory 90 pulses supplied by the oscillator 88 when a release pulse is present on its input 95 and interrupts this transmission when no release pulse is present on its input 95.

Read in and read out means comprising also a second electronic switch 99 (constituted by an AND gate) of which one input 100 is fed by read out pulses furnished by the generator 92 and of which the output 101 is connected to the read out input 102 of the memory 91.

These read in and read out means comprise also a flip flop 103 with two control inputs 104 and 105 and two outputs 106 and 107.

The first input 104 is supplied by the first signal S_1' , the second input 105 is fed by the output voltage of the decoding member 93, the first output 106 is connected to a negative input 108 of the AND gate 99 and the second output 107 is adapted to furnish energising signals.

An energising signal is present on the second output 107 each time that the flip flop 103 is placed in a condition of which the beginning is controlled by the commencement of a release pulse of signal S_1' (the beginning of this release pulse controlling the beginning of reading in by the memory 90 of pulses furnished by the oscillator 88 and the placing in the above-mentioned state of the flip flop 103 controlling, by the output 106 and the input 108, the beginning of reading out of the number contained in the memory 91) and of which the end is controlled by the end of the output voltage of the decoding member 93.

The end of the output voltage of the decoding member 93 is also applied, by means not shown which are known in themselves, to transfer into the memory 91 the number which is contained in the memory 90, this latter memory being thus emptied and ready to effect a new reading in.

According to an arrangement analogous to that of the feed device of FIG. 3, the energising signals present on the output 107 of the flip flop 103 are transmitted to the electromagnet 4 by means of an electronic switch 109 which is constituted by an AND gate of which one input 86 receives the energising signals and of which the other input 87 is supplied by the comparison means 66.

These comparison means 66 are identical to those which have already been described with relation to FIG. 3 and compare the duration T of each energising

signal with a fixed reference period T_R to control, according as T is greater than T_R or not, the passage or interruption of the flow of energising signals to the electromagnet 4.

These energising signals are applied to the electromagnet 4 by a relay 85 and the injection means for fuel into the pipe 1 are similar to those of FIGS. 1 and 3, an energising signal for the opening of the valve 3 and the injection of fuel.

The operation of the feed device of FIG. 6 will now be described by means of the table of FIG. 7.

In this table, there is shown, as a function of time, the first signal S_1' , the content C_1 of the first memory 90, the content C_2 of the second memory 91, the signal i present at the output 107 of the flip flop 103, the signal j present at the output 106 of the flip flop 103, the signal l present at the input 105 of the flip flop 103, the signal m supplied by comparison means 66 at the input 87 of the AND gate 109 and the signal n supplied by the relay 85 to the electromagnet 4.

It will be assumed that at the moment to, a release pulse of the first signal S_1' is applied on the input 95 of the AND gate 94 and on the input 104 of the flip flop 103. It will be assumed also that the memory 91 contains a number p .

The beginning of this release pulse enables the transmission, through the AND gate 94 of pulses emerging from the oscillator 88 to the memory 90 which reads in these pulses as long as the release pulse lasts, the contents of the memory 90 passing from 0 to the number p (curve C_1).

The beginning of this release pulse places the flip flop 103 in a state for which the signal i takes a value "1" and the signal j a value "0". This signal j of value "0" permits the transmission through the AND gate 99 of read out pulses of constant frequency F_2 emerging from the generator 92 to the memory 91 of which the contents C_2 decreases regularly and passes from the number p to the number 0 which is obtained at a moment t_1 .

Between the moments t_0 and t_1 , the decoding member 93 supplies therefore to the input 105 of the flip flop 103 a voltage (signal l) of which the end controls the changing of state of the flip flop 103, the signal i taking the value "0" and the signal j the value "1".

This change of state is applied to transfer into the memory 91 the number p contained in the memory 90, this latter memory being restored to zero.

This cycle is renewed on the arrival, at the moment t_2 , of a new release pulse and it goes on in the same way for each new release pulse.

If the AND gate 109 allows the transmission of signals, the energizing signals formed by each of the pulses of the signal i are transmitted to the electromagnet 4 through a relay 85 of which the actuating signal n is formed by a succession of pulses each having a duration equal to that of the corresponding energising signal. This is the case with energising signals corresponding to the release pulses supervening at moments t_0 and t_2 .

In the case of the energising signal corresponding to the release pulse supervening at the moment t_3 , it has been assumed that, as a result of modification of the degree of opening of the auxiliary throttle member 8, the number p_1 read in at each turn of the rotary member 5 by the memory 90 was less than the preceding number p and that there thereby resulted an energising signal

having a duration T less than the reference duration T_R . The comparison means 66 then actuate the interruption of the transmission of signals through the AND gate 109 and the electromagnet 4 is not energised.

As regards the read in and read out means it has been seen that they provide, on each turn of the rotary member 5, an energising signal on the output 107 of the flip flop 103, the duration T of this energising signal will not be calculated.

It will be assumed that the rotary member 5 rotates at the speed of N turns per second. The duration of each release pulse of the signal S_1' is hence equal to $(r/360) \cdot (1/N)$ and the number p which is read in by the memory 90 on each release pulse is hence equal to $(r/360) \cdot (1/N) \cdot F_1$ if F_1 is the frequency of the oscillator 88.

It will be assumed that:

$$F_1 = F_0 \cdot f(\alpha) \quad (11)$$

$f(\alpha)$ being a function of which the value varies in the same sense as the degree of opening α of the auxiliary throttle member 8 and F_0 being a fixed frequency.

The time T applied by the generator 92 to effect the reading out of this number p in the memory 91 is equal to:

$$T = p/F_2 = r/360 \cdot 1/N \cdot F_1/F_2 \quad (12)$$

F_2 being the fixed frequency of the generator 92.

By combining the equations (11) and (12) and by taking into account the constant terms, there is obtained:

$$T = k'/N \cdot f(\alpha)$$

As a result the fraction $T \cdot N$ of each turn of the rotary member 5, during which the energising signal is sent to the electromagnet 4 and during which the valve 3 allows the injection of fuel into the pipe 1, depends only on the degree of opening of the auxiliary throttle member 8.

Just as in the feed device of FIG. 3, the speed of rotation of the rotary member 5 has no influence on the value of this fraction of a turn.

The function $f(\alpha)$ depends against on the shape of the active surface 26 of the cam 18 and may be determined experimentally.

As regards the comparison means 66, they suppress the injection of fuel into the pipe 1 of the internal combustion engine when this engine operates under conditions which enable the supply of fuel to be cut off, especially when the engine is driven by the vehicle (deceleration).

Finally, whatever the embodiment adopted, in the case where it is necessary to control a plurality of valves 3, there may be envisaged having as many signal generators and sensors 23 as electromagnets 4 to be controlled or there may be provided a rotary member 5 on which are keyed a corresponding number of magnetic masses 24 rotating in the vicinity of a single sensor 23 releasing a single signal generator, a distributor enabling the energising signals supplied by the generator to be directed to the corresponding electromagnets.

Finally, whatever the embodiment adopted, there is obtained a compact, simple and economic device.

In particular, the adjustment of the fraction of a turn is effected by an electronic method and no longer by a mechanical method. The connection between the rotary member 5 and the signal generator 6, 6a or 6b, controlling the opening of the valves 3 in the delivery circuit, is done by electrical conductors, which simplifies distinctly the positioning of the feed device.

In addition, the durations of the energising signals controlling the injection are calculated with a great precision by the computing devices.

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

I claim:

1. A fuel feed device for internal combustion engines comprising, in an intake pipe of the engine, a main throttle member actuated by the driver, a source of fuel under pressure, a delivery circuit in fluid communication with said fuel source and which opens into the portion of the intake pipe situated downstream of the main throttle member, at least one valve positioned to control said delivery circuit, an electromagnet in operative relationship for actuating said valve, and a metering system which comprises a rotary member rotated continuously and independently from any necessary synchronization with said engine and an auxiliary throttle member and arranged to be opened or closed automatically and progressively to a degree which is a function of the flow rate of air in said pipe as it increases or decreases respectively, said metering system being adapted to send into the electromagnet at least one energizing signal during a fraction of each turn of the rotary member, said fraction varying in proportion only as the degree of opening of auxiliary throttle member, which is governed by said flow rate of air, the metering system comprising means operatively associated with said rotary member for generating a first electrical signal on each turn of the rotary member, means sensitive to the degree of opening of the auxiliary throttle member for generating a second electrical signal representative of the degree of opening of said auxiliary throttle member, and signal forming means receiving said second signal and responsive to each said first signal for generating one of said energizing signals during a fraction of the corresponding turn of the rotary member which is a function of said second signal only.

2. Device according to claim 1, wherein the generator of electrical signals comprises a capacitor, a variable resistance sensitive to the position of the said auxiliary throttle member and switch means adapted to control successively, and at each turn of the rotary member, the charge of said capacitor during rotation of a predetermined angle (α) of this rotary member and the discharge of said capacitor into the circuit constituted by the variable resistance and by a threshold device connected in series, the threshold device sending into the electromagnet an energising signal as long as the discharge current is higher than a given threshold.

3. Device according to claim 2, wherein the switch means have two stable states, a first state corresponding to the charging of the capacitor and a second state corresponding to the discharging of the capacitor, said means being controlled by a signal furnished by a field sensor in the neighbourhood of which is rotated a magnetic mass rigidly fixed to said rotary member, a rotation of a predetermined angle (α) of the magnetic mass generating in the sensor, on each turn of said rotary member, a release signal of which the start actuates the placing in the first state of said switch means and of which the end actuates the placing in the second state of said switch means.

4. Device according to claim 2, wherein the variable resistance is constituted by a rheostat provided with a movable slider whose displacements are actuated by the movements of a cam which is rigidly fixed to the auxiliary throttle member and which comprises an active surface bearing on a mechanical connecting member movable with said slider.

5. A fuel feed device for an internal combustion engine having an intake pipe and a driver actuated main throttle member in said pipe, said device including:

at least one valve for delivering fuel under pressure to a portion of the intake pipe of the engine downstream of said main throttle member, said valve being of a type substantially insensitive to the pressure prevailing in said intake pipe,

electro-magnetic means for opening said valve upon energization thereof,

an auxiliary throttle member located in said intake pipe upstream of the main throttle member and arranged to be opened automatically and progressively in proportion with increase of the flow rate of air in said intake pipe,

fuel pressure regulator means responsive to the pressure in said intake pipe for delivering fuel to said valve under a pressure which is substantially proportional to the air pressure in said intake pipe between said auxiliary throttle member and main throttle member,

and a fuel metering system for delivering to said electro-magnetic means electrical actuating pulses for opening said valve, said metering system comprising means for generating a sequence of first electrical signals independently from any necessary synchronization with said engine and electrical circuit means controlled by said auxiliary throttle member for generating, responsive to each said first electrical signal, an energizing signal during a time which is a fraction of the time period between two successive said first signals which depends on the position of said auxiliary throttle member only.

6. A fuel feed device according to claim 5, wherein said means for generating a first electrical signal comprises a rotary member rotated continuously and independently from any necessary synchronization with said engine, and means for generating one of said first electrical signals on each turn of the rotary member.

7. A fuel feed device according to claim 6, wherein said electrical circuit means comprises signal forming means connected to receive said first signal and including an electrical component whose value is controlled by said auxiliary throttle member, whereby an energizing signal is delivered responsive to each said first electrical signal and during a time which is a fraction of the duration of the corresponding turn of the rotary member which is a function of said degree of opening only, and said fraction remains constant so long as the flow rate of air in the intake pipe remains constant.

8. Device according to claim 5, wherein said signal forming means comprises a computing device adapted to provide said energizing signal from said first signal which begins when said member is in a predetermined angular position and ends when said rotary member has effected a rotation of a predetermined angle and a second signal which represents the measurement of the degree of opening of the auxiliary throttle member.

9. Feed device according to claim 8, wherein said first signal is constituted, on each turn of the rotary

member, by a release pulse of which the beginning is concomitant with the passage of said rotary member through a fixed and predetermined angular position and said second signal is constituted by a continuous voltage whose value depends on the degree of opening of the auxiliary throttle member, and wherein said computing device comprises a modulation member adapted to furnish, when it is placed in action by the beginning of a release pulse, an output voltage for a time comprising a constant period and a period proportional to the value of an input voltage furnished to said modulation member, the output of said modulation member being connected to its input through a loop in which are arranged successively, in series, an integrator adapted to integrate the output voltage during an interval of time comprised between the commencements of two successive release pulses, a comparator adapted to effect the difference between the output signal of the integrator and said second signal and a high gain amplifier adapted to transmit said difference amplified to the input of the modulating member, the energising signal being constituted by the output voltage of said modulating member.

10. Feed device according to claim 8, in which said first signal is constituted, on each turn of said rotary member, by a release pulse whose duration is proportional to the duration during which said rotary member effects a rotation of a predetermined and constant angle and said second signal is constituted by a continuous voltage whose value depends on the degree of opening of the auxiliary throttling member, wherein the computing device comprises an oscillator adapted to deliver pulses with a frequency dependent on the value of said second signal and reading in and reading out means adapted, on each release pulse, on one hand, to count the number of pulses delivered by said oscillator during the duration of the release pulse and, on the other hand, to read out with a given and constant rhythm the number of pulses delivered by said oscillator during the duration of the preceding release pulse, said reading in and reading out means providing, on each reading out a signal whose duration is proportional to the magnitude of the number of pulses read out and which constitutes the energising signal.

11. Feed device according to claim 9, wherein the signal forming means comprises a flip flop with two actuating inputs and two outputs, the first actuating input being fed by the first signal, the second actuating input being fed by the output voltage of the modulating member, the first output being connected to an input for bringing into action the modulating member and the second output being adapted to furnish the energising signal, said energising signal being present on the second output when the flip flop is placed in a state whose start is actuated by the beginning of the release pulse and whose end is actuated by the end of the output

voltage furnished by the modulating member.

12. Feed device according to claim 10, wherein the reading in and reading out means comprise a summation means provided with a first memory adapted to read in the number of pulses delivered by the oscillator during the duration of a release pulse and a second memory adapted to record said number and to provide, under the action of a generator of fixed frequency read-out pulses, a signal constituted by a succession of said same number of read-out pulses, the succession of read-out pulses being applied to a decoding member adapted to supply an output voltage constituting the energising signal for a duration equal to that of said succession of read-out pulses.

13. Feed device according to claim 12, wherein the readin and read-out means comprise a first electronic switch which is interposed between the first memory and the oscillator and which is actuated by the first signal so that the pulses delivered by the oscillator are only transmitted to the first memory during the duration of the release pulse, a second electronic switch which is interposed between the read-out pulse generator and the second memory and which is actuated by the first signal so that the pulses delivered by the read-out pulse generator are transmitted to the second memory from the beginning of the release pulse of the first signal and a flip flop with two actuating inputs and two outputs, the first actuating input being supplied by the first signal, the second actuating input being fed by the output voltage of the decoding member, the first output being connected to the actuating input of the second electronic switch and a second output being adapted to supply the energising signal, said energising signal being present on the second output when the flip flop is placed in a state whose beginning is actuated by the beginning of the release pulse and whose end is actuated by the end of the output voltage of the decoding member.

14. Feed device according to claim 8, wherein the energising signal is transmitted to the electromagnet through an electronic switch which is actuated by comparison means adapted to compare the duration of each energising signal to a corresponding fixed reference duration, so that said switch is closed and ensures the transmission of energising signals to the electromagnet when the duration of said energising signals is greater than said reference duration and said switch is open and does not transmit energising signals to the electromagnet when the duration of said signals is less than the reference duration.

15. Fuel feed device according to claim 14, wherein said fixed reference duration is the duration of the energising signal when the internal combustion engine operates at slow speed.

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