United States Patent

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[72] Inventor **Giampaolo Garcea**
Milan, Italy

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[73] Assignee **Alfa Romeo S.p.A.**
Milan, Italy

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[33] **Italy**
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[54] **REGULATOR DEVICE FOR A VARIABLE RATE OF FLOW FOR A FUEL INJECTION PUMP FOR AN INTERNAL COMBUSTION ENGINE**
1 Claim, 3 Drawing Figs.

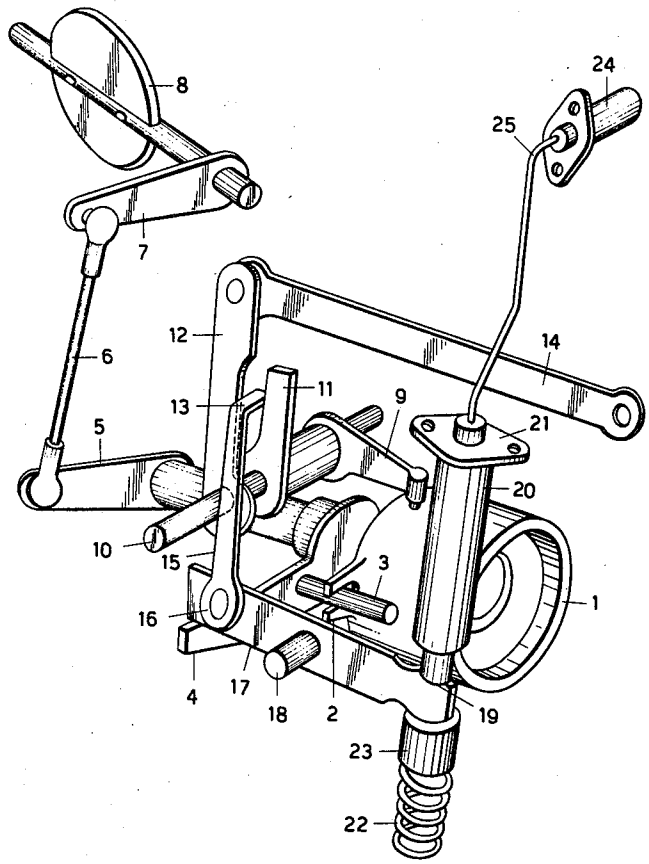
[52] **U.S. Cl.** **123/140,** 123/119, 123/139
[51] **Int. Cl.** **F02d 1/04**
[50] **Field of Search** 123/119, 139.17, 139.18, 139, 140, 140.2, 140.3, 179, 140.31

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Primary Examiner—Laurence M. Goodridge
Attorney—Holman & Stern

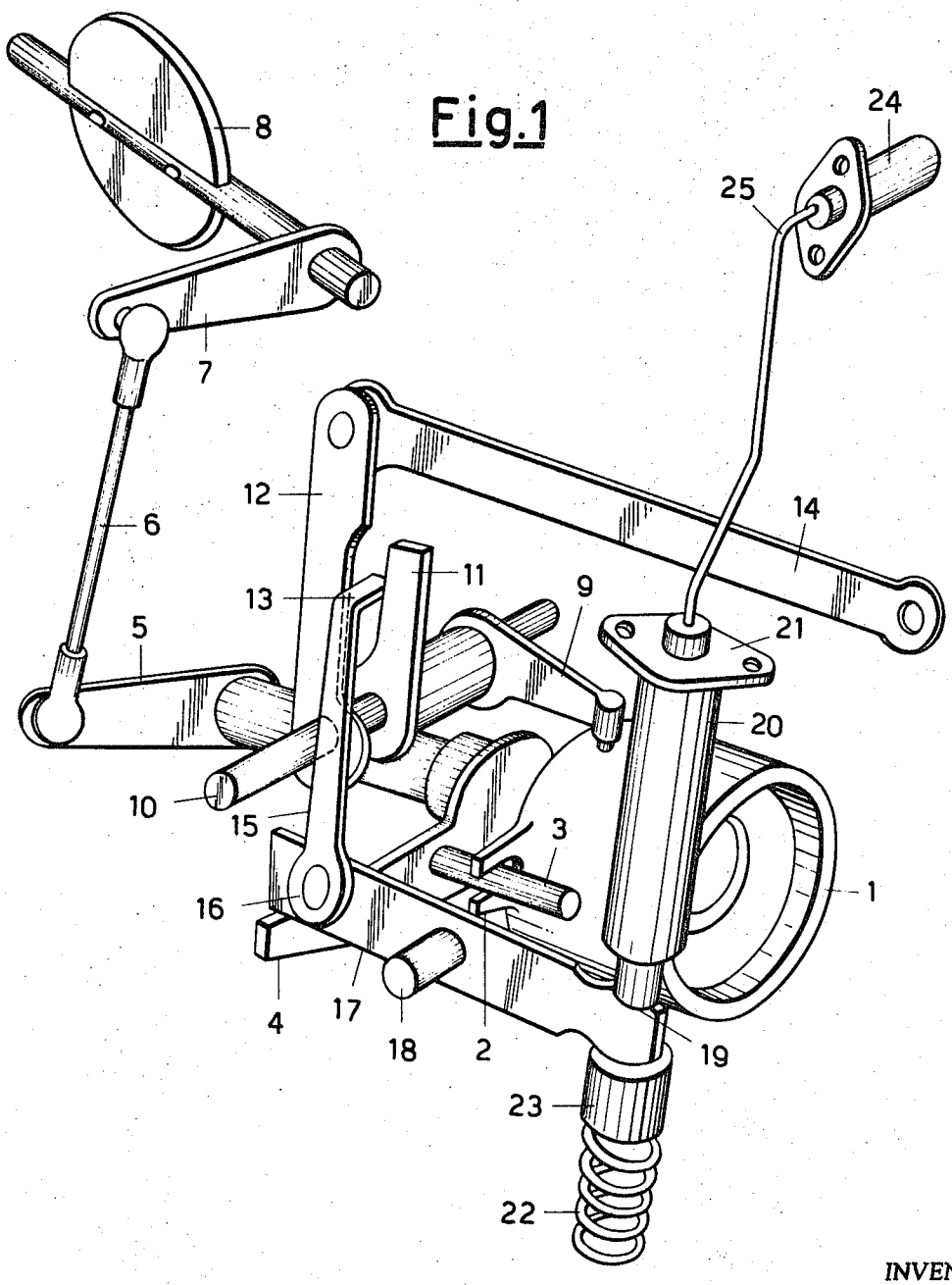
ABSTRACT: Regulator unit for a gasoline injection pump, which provides the automatic control of the idle running speed when the internal combustion engine has not reached its working temperature, comprising a thermostatic device which automatically moves a catch forming the limiting stop, which in turn controls the angle of opening of the throttle (or throttles).



PATENTED MAY 11 1971 3,577,978

SHEET 1 OF 3

Fig.1



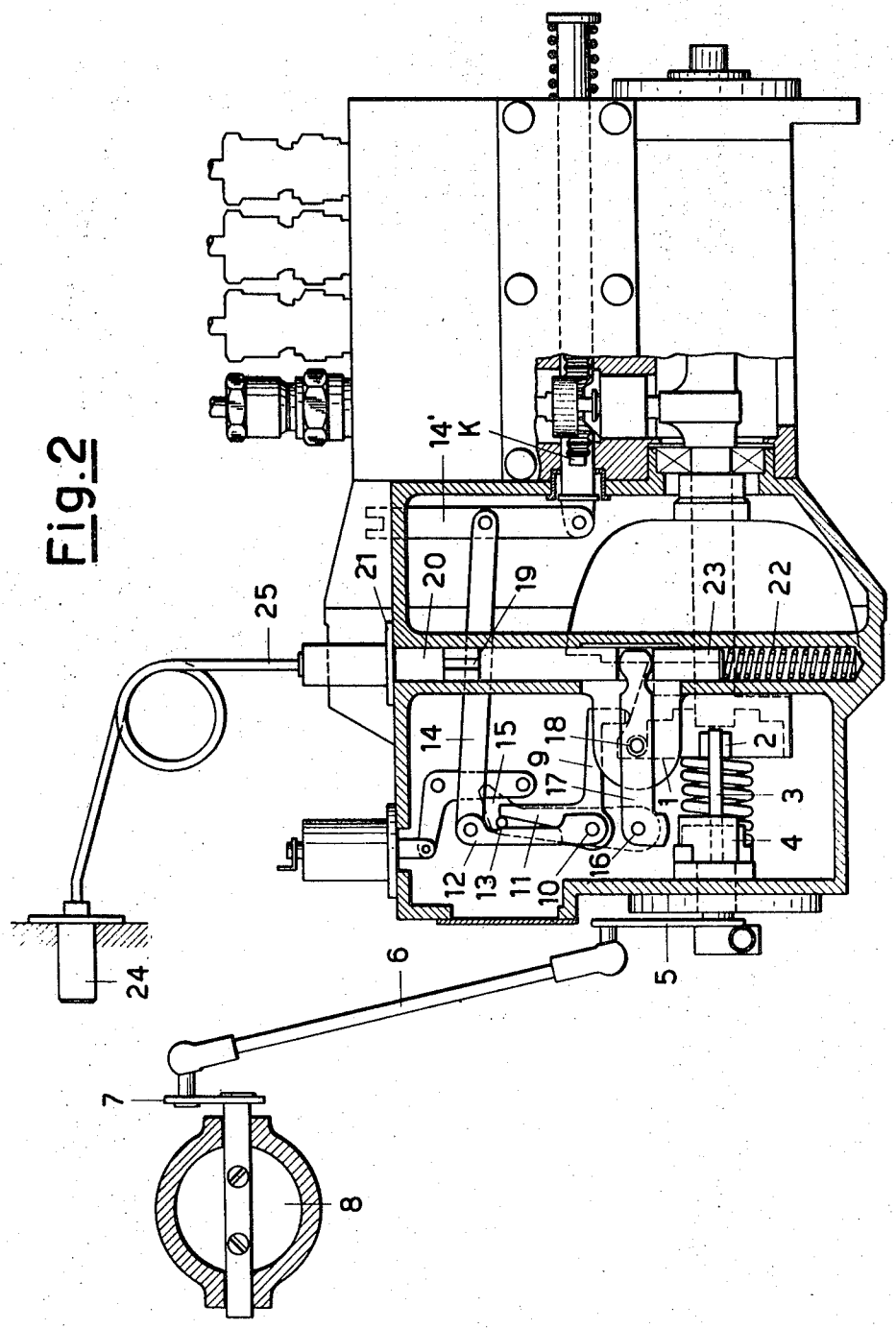
INVENTOR

GIAMPAOLO GARCEA

BY Holman, Glascock, Downing & Seebold

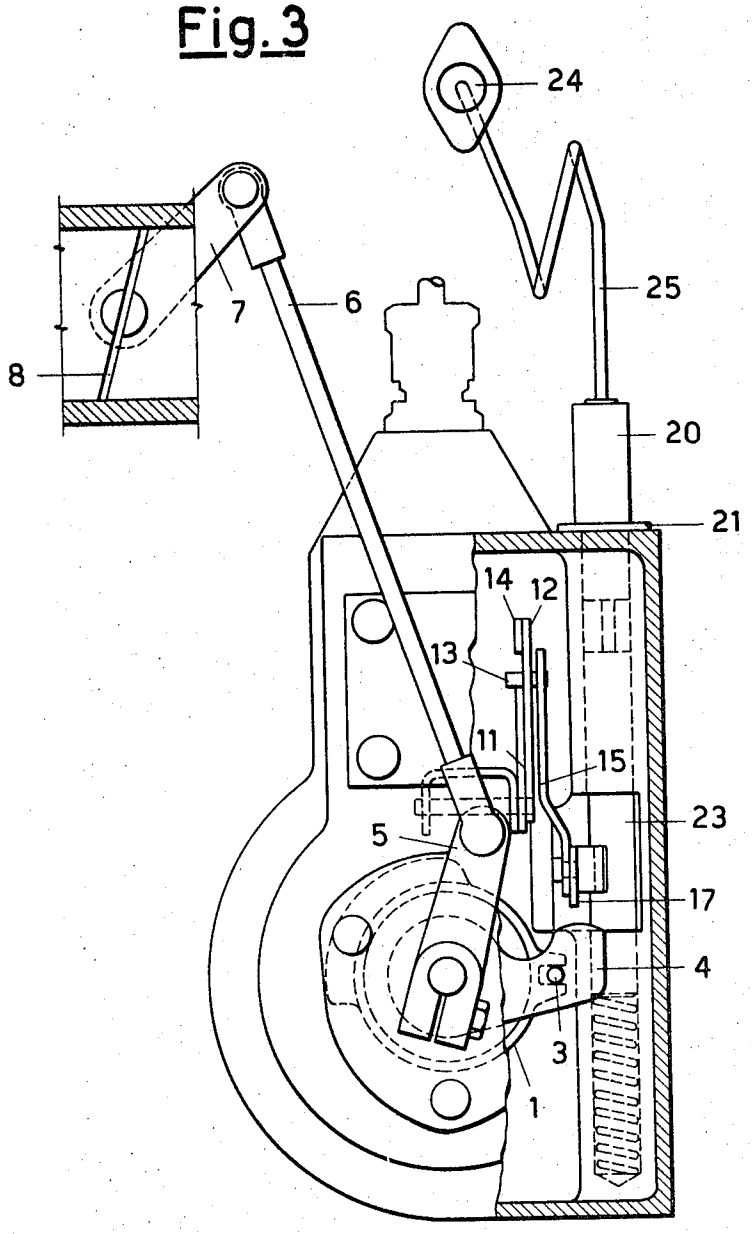
ATTORNEYS

Fig. 2



INVENTOR
GIAMPAOLO GARCEA

Fig.3



INVENTOR
GIAMPAOLO CARCEA

BY Holman, Glascock, Downing & Seebold

ATTORNEYS

REGULATOR DEVICE FOR A VARIABLE RATE OF FLOW FOR A FUEL INJECTION PUMP FOR AN INTERNAL COMBUSTION ENGINE

BACKGROUND OF THE INVENTION

It is well known that certain types of regulators for gasoline injection pumps for internal combustion engines have as their essential element a three-dimensional cam with a tracer point acting on its surface. The cam is automatically moved with respect to the tracer point in two different directions which correspond to the varying of the rotational speed of the internal combustion engine and of the angle of the throttle (or the varying of the position of the member which throttles the air aspirated by the motor). The extremity of the tracer point is thus moved in a direction orthogonal to the two preceding directions in accordance with the corresponding levels (or "rises") of the spacial surface which it touches.

The device of the pump, for example the rack rod for piston pumps, is kinematically linked to the tracer point and varies the quantity of gasoline injected. As the levels of the spacial surface are such as to ensure that the quantity of gasoline injected is that appropriate to each pair of values of the two mentioned parameters (speed of the engine, position of the throttle), a basic adjustment is, by this means, obtained.

Supplementary devices bring about variations (corrections) to these adjustments, for example according to the variation of density of s aspirated air with the level, when a richer mixture is required for a cold engine which has not yet reached its working temperature.

The object of this invention is to provide a device supplementary to the regulators of the type mentioned above, which permits the automatic control of the idle running speed when the internal combustion engine has not yet reached its working temperature. In fact, in order to guarantee a regular operation when idling with the engine cold and without the engine spontaneously stalling, it is not sufficient just to increase the quantity of gasoline injected in order to make up for the incomplete utilization of the gasoline itself (which has difficulty in evaporating and burning), but it is also necessary to increase the quantity of air. This increase in quantity of air, accompanied by a corresponding increase in injected quantity of gasoline, permits the motor to provide for the larger power required in order to run in the idling condition with the engine and oil cold.

Generally, with the regulators actually in use for these purposes, when the engine is cold the quantity of supplementary air is made to pass through a valve (adjusted automatically or by hand) thus short-circuiting the throttle whose position at minimum opening (for operation at minimum power) remains unaltered. Because of the fact that inside the regulator a thermostatic device is used to provide for the correction of the basic adjustment for the enrichment necessary when the engine has not yet reached its working temperature, the valve for increasing the quantity of air in the idling condition when the engine has not yet reached its working level is also located inside the regulator and also controlled by the same thermostatic device.

Obviously a suitable small pipe connects the exit of the valve to the principal aspiration pipe of the motor downstream of the valve.

This generally adopted solution proves to be inadequate for the following reasons:

a. It does not permit a perfect proportioning of the quantity of gasoline injected with respect to the air aspirated by the engine. The three dimensional cam device which controls the basic adjustment of the mixture cannot take into account in fact the quantity of air which passes through the idling valve when the engine is cold, neither can it be taken into account by the correction device for enrichment of the mixture provided for power requirements above the minimum when the engine is still cold.

b. It impedes the obtaining of those elevated specific powers from the engine which require considerably overlaps in the opening of the aspiration and discharge valves. In fact with such timing, regularity when idling and at a high degree of throttling can be obtained only by feeding the various cylinders separately. Obviously, the valve for supplementary air with the engine cold, feeds all the cylinders simultaneously, and inside the regulator there obviously cannot be provided as many valves as there are cylinders, all controlled by the thermostatic device and each one connected by means of a suitable pipe to the corresponding cylinder.

SUMMARY OF THE INVENTION

In the regulator which forms the object of this invention, the supplementary quantity of air is obtained not by means of the opening of the valve but instead by suitably altering, when the engine is cold, the position provided on the throttle (or throttles) for idle running with the engine hot, as the minimum opening of the throttle (or throttles) is larger the lower the temperature of the engine, i.e., the further the motor is from its working temperature.

This new proposed solution can also be attained by utilizing the same thermostatic device provided for the correction relative to the mixture requirements when the engine is cold, with this device being located inside the regulator. In fact, this invention provides for the thermostatic device to automatically move the catch forming the limit stop of the three-dimensional cam as the temperature varies, with the limit stop limiting that movement of the cam which depends upon the angle of opening of the throttle (or throttles).

With the kinematic linkage between the three dimensional cam and the throttle (or throttles), there is thus obtained the automatic adjustment of the minimum degree of opening of the throttle (or throttles) in relation to the temperature of the motor which has not yet reached its working condition.

The difficulties mentioned above under points (a) and (b) with regard to the traditional solution are overcome by the solution provided by this invention.

Regarding point (a), it is evident that with the proposed solution both the device for basic adjustment and the corrective device for enriching of the mixture with the engine still cold can take into account the supplementary air, which is obtained by a larger opening of the throttle (or throttles). The regularity of operation of the engine and the not only "approximate" but perfect adjustment of the mixture at the idling and close to idling conditions of the engine which has not yet reached its working temperature are, as is known, essential for the reduction of emission of carbon monoxide and unburnt hydrocarbons in cities, to such an extend that these conditions are particularly controlled by statute requirements.

Regarding point (b), the solution proposed allows the feeding of the various cylinders with air separately even at the idling and low power conditions, seeing that the supplementary air is fed by passing through the throttles of the separate cylinders, so that it is possible to obtain the maximum specific powers even though maintaining optimum regularity at idling and low power conditions.

For clarification of what has been said above, reference is made in the following to the embodiment illustrated by way of example in the accompanying drawings in which:

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view in diagrammatic form of the elements which comprise the regulator;

FIG. 2 is a longitudinal section through the regulator and

FIG. 3 is a side view partially in section.

DETAILED DESCRIPTION OF THE INVENTION

The FIGS. show the three-dimensional cam 1 in the shape of a drum which slides axially as a function of the speed of rotation of the engine as it is subjected axially to the force deriving from a centrifugal device and the force acting against this latter which is furnished by one or more springs. Neither the centrifugal device nor the springs are shown in the FIGS. for simplicity.

In addition to this possibility of axial movement as a function of the rotational speed of the engine, the drum cam **1** can also rotate around its axis as a function of the rotations of a throttle **8** or at least of the movements of the member which throttles the air feeding the engine. A cylindrical rod **3** rigidly fixed to a lever **4** is engaged in a suitable link block **2** rigid with the cam and rotates around an axis which coincides with the axis of the drum cam. The rotations of the lever **4** are determined by the rotations of a lever **5** rigidly fixed thereto. The lever **5** located outside the housing of the regulator containing the cam and other regulating members is kinematically linked by means of the tie rod **6** to a lever **7** which is rigidly fixed to the throttle **8**. In this way as stated the drum cam rotates around its axis as a function of the rotations of the throttle around its axis.

A tracer point or feeler member **9** is maintained in contact with the external surface of the drum cam, with this surface being suitably shaped as a spacial cam, and thus this tracer point rotates around a fixed axis **10** according to the position of the drum cam and the levels of its surface, and causes lever **11** which is rigid with the tracer point to rotate.

A lever **12** can also rotate around the same axis **10** dragged by the lever **11** by means of a projection **13** interposed between two suitably shaped surfaces of the lever **11** and the lever **12**. The lever **12** controls the device for the pump, for example a rack rod K for a piston pump, by way of a tie rod **14** and lever **14'**, so varying the quantity of gasoline injected, with the pump device being of known type.

The above-mentioned projection **13** is rigid with a rod **15** which has a fulcrum at **16** rigid with a lever **17**, which has a fixed fulcrum at **18**. The lever **17** can rotate at the fixed fulcrum **18** as a function of an actuator element **19** of a thermostat **20** which is fixed to the box of the regulator by means of a flange **21**. A spring **22** maintains the extremity of the lever **17** in contact with the extremity of the actuator **19** by means of a ferrule **23** which slides in a suitable cylindrical housing rigid with the box of the regulator. The movements of the actuator **19** arise as a function of the temperature of the engine by the effect of variations in the volume of a fluid contained in a space **24** which senses the temperature of the engine, in the specific case of the temperature of the cooling liquid of the engine itself. Variations in volume of the fluid contained in the space **24** are transmitted to the thermostat **20** by way of a tube **25**. The fulcrum **16** hence assumes different positions according to the temperature of the engine and in consequence, the projection **13** assumes different positions with respect to the two surfaces of the lever **11** and the lever **12** between which the projection is interposed, and the different positions of the projection **13** consequently give rise to a different angle between the lever **12** and the lever **11**, as a function also of the development of the two surfaces of the lever **11** and the lever **12** in contact with the tracer point. For a constant position of the tracer point **9**, the different angles made by the lever **12** with respect to the lever **11** give rise to variations in the quantity of gasoline injected, to conform to the requirement of the engine of a mixture which needs to be richer the colder the engine. By means of the rotations of the lever **17**, the thermostat **20** simultaneously provides for increasing the quantity of air aspirated in the idle condition when the motor is cold because as the throttle **8** is kinematically linked to the lever **4**, it can close itself down towards the idle position only up to the point where an appropriate extremity of the lever **4** touches the appropriate surface of the lever **17**, and this latter assumes different positions as mentioned above according to the position of the actuator **19** and consequently of the temperature of the engine.

In addition to the throttle **8** indicated in the drawing, other throttles rigidly fixed to the shaft of the throttle **8** or kinematically linked with the tie rod **6** or the lever **5** can naturally have their position corresponding to operation of the engine in the idling condition when the temperature of the engine is different from that at full working condition adjusted by the device now described.

I claim:

1. In a regulator device for a variable rate flow for a fuel injection pump for a water cooled internal combustion engine, a throttle, a three-dimensional cam capable of displacement in two different direction according to the engine r.p.m. and the position of the throttle, a feeler member rotatable about a fixed axis, said feeler member being maintained in contact with the periphery of the cam, and correcting means located between the feeler **1** member and a movable component of the fuel injection pump serving to vary the fuel flow rate, (said correcting means comprising an auxiliary), said correcting means comprising an auxiliary lever, a pivot for the auxiliary lever at one end thereof, the axis of the pivot being parallel to the axis of rotation of the feeler member and adjacent to the axis, a projection at the other end of the auxiliary lever, a first lever rigidly rotatable with the feeler member, a second lever rotatable about the fixed axis, the projection of the auxiliary lever being located between a surface of the first lever and a surface of the second lever, means connecting the second lever to the movable component of the fuel injection pump, the pivot of the auxiliary lever being displaceable whereby substantial components of such displacement are in a direction parallel to said two surfaces, thermostatic means sensitive to the temperature of the engine cooling water, the displacements of the pivot of the auxiliary lever being executed from the thermostatic means through a lever arm as a function of the proper temperature of the internal combustion engine, the shapes of said two surfaces being such as to contact the projection for originating and increasing the rate of flow as is necessary under cold engine conditions with respect to the rate of flow corresponding to an engine running under proper conditions, said three-dimensional cam being provided with a U-shaped link block, a cylindrical rod slidably engaged in the link block so that the axial displacements of the three-dimensional cam can take place, while any rotation of said cam is controlled by said rod, a third lever rotatable about the same rotation axis of the three-dimensional cam, said cylindrical rod rigidly protruding from said lever, linkage means between the third lever and the throttle whereby any rotation of the throttle causes a corresponding rotation of the third lever and of the three-dimensional cam, and the free end of said third lever being engaged from said lever arm when the running temperature of the engine is below the normal value under the control of said thermostatic means.