

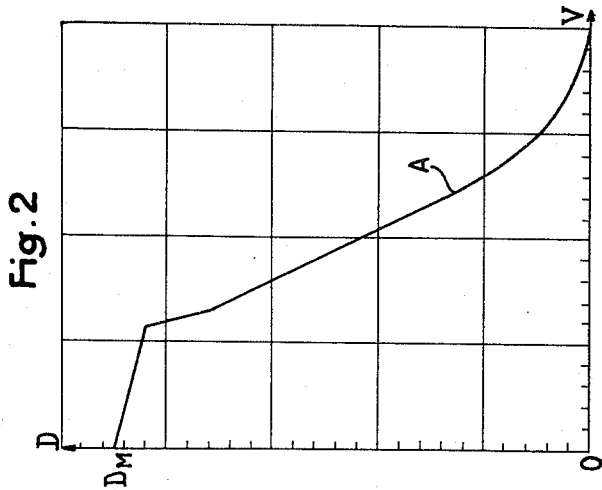
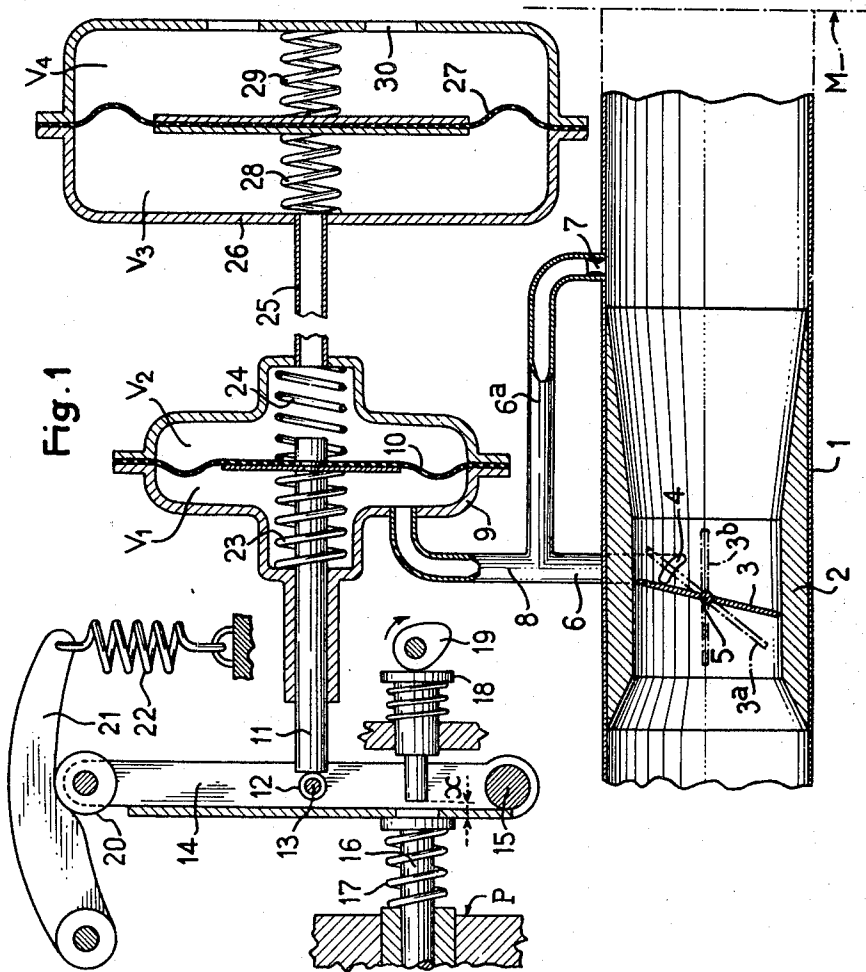
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DEVELOPMENT OF A FUEL INJECTION PUMP FOR AN INTERNAL
COMBUSTION ENGINE AS A FUNCTION OF THE DEPRESSION
PREVAILING IN THE INDUCTION PIPE

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DEVICE FOR REGULATING A FUEL INJECTION PUMP FOR AN INTERNAL COMBUSTION ENGINE AS A FUNCTION OF THE DEPRESSION PREVAILING IN THE INDUCTION PIPE

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ABSTRACT OF THE DISCLOSURE

Device for regulating a fuel injection pump for an internal combustion engine, the device comprising an induction pipe having a venturi portion, a throttle in the neck of the venturi, a first aperture in the wall of the neck and a second aperture in the wall of the induction pipe downstream of the venturi, the first aperture being wholly on the downstream side of the throttle for idling speeds and partly on the upstream side for the beginning of an acceleration, the two apertures being both connected to a chamber having a yieldable wall controlling the flow of fuel from the injection pump.

The present invention relates to regulating devices which, as a function of the suction prevailing in the induction pipe of an internal combustion engine, regulate the fuel injection pump in such manner as to vary the volume of fuel injected in accordance with the operational speed of the engine.

Various regulating devices are known of the type having an actuating diaphragm subjected on one side to a suction which is a function of that prevailing in the induction pipe, one of the sides of this diaphragm defining a chamber which is connected to a single suction take off located on the downstream side of the throttle regulating the supply of air to the induction pipe of the engine.

These known devices are usually provided with a corrector actuated by a regulator or governor, which may be of the centrifugal type driven by the engine, thereby ensuring the necessary corrections of the flow of fuel as a function of the speed of the engine, otherwise this flow would be too great when accelerating and too little in full throttle operation.

The object of the present invention is to provide a regulating device of the aforementioned type having a diaphragm which provides the desired flow curve as a function of the speed of the engine solely by use of the suction prevailing in the induction pipe of the engine. This is obtained owing to the fact that the chamber, which is subjected to the suction and is defined by the actuating diaphragm is connected to the induction pipe of the engine, which pipe includes a Venturi and an air entry regulating throttle located in the neck of the Venturi, by way of a suction take off formed by two conduits in parallel, one of which communicates with a first aperture placed in the neck of the Venturi and having such position and/or shape that it is wholly on the downstream side of the gas throttle for the idle speed position of the throttle whereas a part of this aperture is on the upstream side of the throttle as soon as the latter occupies a position corresponding to the beginning of an acceleration, the other conduit communicating with a second aperture located on the downstream side of the Venturi.

In this way, there is automatically obtained a slight drop in the suction acting on the diaphragm during the acceleration, this being consequently as a function of

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the speed of the engine, and a slight increase in this suction in full throttle operation since in this case the suction prevailing in the neck of the Venturi exceeds that prevailing on the downstream side thereof.

According to another feature, the other side of the diaphragm—which is subjected to the action of antagonistic springs—defines a second chamber connected to a third chamber formed by a first face of a second diaphragm which is in equilibrium between two antagonistic springs, the second face of the last-mentioned diaphragm communicating with the atmosphere, whereas the second chamber and the third chamber are isolated from the atmosphere.

This assembly constitutes a corrector of the flow as a function of the barometric pressure and surrounding temperature.

Further features and advantages of the invention will be apparent from the ensuing description with reference to the accompanying drawings to which the invention is in no way limited.

In the drawings:

FIG. 1 is an elevational view, partly in section, of the device according to the invention applied by way of example to a volumetric injection pump whose flow variation is obtained by varying the travel of the piston, and

FIG. 2 is a graph of the flow variation (abscissae) as a function of the suction (ordinates) prevailing in the induction pipe of the engine.

In the illustrated embodiment, disposed in the induction pipe 1 of the engine M is a Venturi 2 in the neck of which is located the throttle 3 regulating the entry of air into the engine.

Provided on the downstream side of the throttle, and very near to the latter, is a first aperture 4 formed in the body of the Venturi at a suitable distance from the pivot pin 5 of the throttle 3.

The shape of this first aperture 4 can more or less approximate that of a round aperture. However, the best results are obtained with a "haricot bean" shape. The aperture 4 is connected by conduits 6 and 6^a to a second aperture 7 formed in the induction pipe 1 on the downstream side of the Venturi and the apertures 4 and 7 are connected by conduits in parallel 6 and 6^a and a common pipe 8, to an enclosure 9.

This enclosure contains a flexible diaphragm 10 capable of moving under the effect of the suction and bearing through the medium of a push rod 11 on a roller 12 which is freely rotative on a pin 13 carried by a lever 14. This lever is pivotal about a fixed pin 15 and regulates the travel of the piston 16 of the injection pump, this piston 16 being driven in the known manner in opposition to the action of a spring 17 by a push rod 18 and a cam 19 driven by the engine M.

It can be seen that any movement of the diaphragm 10 results in a variation in the clearance x between the piston 16 and the push rod 18 and consequently in a variation in the effective travel of the piston 16 of the injection pump.

At its end opposed to the pin 15, the lever 14 carries a roller 20 on which bears a cam-shaped level 21. The contact between the two elements 20 and 21 is constantly ensured by a spring 22. The force exerted by the suction on the diaphragm 10 is therefore constantly balanced by the combined actions of the spring 22 and of a spring 23 acting on the diaphragm 10 in opposition to the action of a spring 24. Further, it is the shape of the cam 21 and the flexibility of the springs 22, 23 and 24 which give the desired shape to the curve A representing the volume V injected (abscissae) as a function of the suction D (ordinates). It will be observed that the device completely cuts off the injection when the suction reaches a value D_M.

The diaphragm 10 divides the enclosure 9 into two chambers V_1 and V_2 . The chamber V_1 is connected to the induction pipe of the engine by the pipe 8. The chamber V_2 is connected by a pipe 25 to an auxiliary enclosure 26 which is divided into two chambers V_3 and V_4 by a flexible diaphragm 27 movable within the enclosure 26. This diaphragm is held in position by two antagonistic springs 28 and 29. The chamber V_4 of the enclosure 26 communicates freely with the atmosphere through the aperture 30. The chambers V_2 and V_3 are interconnected in a fluidtight manner and are filled with air at the pressure of the atmosphere of the region in which the carburation is regulated.

The device operates in the following manner:

(a) *Idling speed and acceleration*

As soon as the engine is started up at idling speed, the suction in the induction pipe 1 is very high. The diaphragm 10 exerts a strong force on the springs 22 and 23 and the clearance x is great. This corresponds to injection of very small amounts of fuel. The suction in the pipes 6 and 8 is the same as in the induction pipe 1.

When the engine is accelerated by turning the throttle 3 to the position 3^a shown in dot-dash line, it can be seen that a part of the suction take off 4 is then on the upstream side of the throttle and therefore connected to atmospheric pressure. Air will enter this part of the take off 4 and the suction in the pipe 8, and consequently the chamber V_1 , will be slightly less than in the induction pipe 1. This suction will be the lower as the part of the take off 4 put in communication with atmospheric pressure is greater. The difference in the suctions prevailing in the pipe 1 and the pipe 8 will be maximum when the take off 4 is wholly connected to atmospheric pressure, that is, is on the upstream side of the throttle 3.

Thus it can be seen that in its angular displacement the throttle 3 sweeps over the entire area of the aperture 4. Now, for a constant given suction, there is at each speed of the engine a different position of the throttle 3.

For instance, if there are 200g of suction in the induction pipe 1, the opening of the throttle 3 will be for example 4° at 1500 r.p.m. of the engine and 10° at 4000 r.p.m. These figures are given merely by way of example.

Thus, it is clear that the suction take off aperture 4 thus designed affords a correction which is a function of the operational speed of the engine. The value of this correction is a function of the ratio between the sections of the apertures 4 and 7. If S is the area of aperture 7 and s the area of aperture 4, the correction is great if S/s is small; it is small if the ratio S/s is great. By correction is meant the difference between the suctions prevailing in the pipes 1 and 8, that prevailing in pipe 1 being the greater.

(b) *Operation under full throttle conditions*

It is known that under full throttle conditions, the engine filling coefficient decreases when the speed increases. In respect of engines having a bad filling coefficient at high speeds, it might be necessary to decrease the volume of fuel injected.

The suction take off of the device according to the invention provides a curve of the fuel flow as a function of the speed which is proportional to the engine filling curve. Indeed, under full throttle conditions, the throttle is wide open at 3^b. The suction at 4 in the neck of the Venturi is higher than the suction at 7 in the pipe 1. In the pipes 6 and 8 there is therefore a suction which is intermediate those measured at 4 and 7. This intermediate suction increases nonetheless with the speed of the engine and, as it is applied on the corresponding face of the diaphragm 10 in the chamber V_1 , there is in fact an increase in the clearance x and consequently a decrease in the volume of fuel injected as a function of the speed. This decrease is set at the desired value by adjusting the stiffness of the springs 23 and 24.

(c) *Altimetric correction as a function of the temperature*

The enclosure 26 performs the function of an altimetric and temperature corrector. If this enclosure 26 were indeformable, the air contained therein would, in accordance with the law of perfect gases, increase a little too much in pressure and would provide an excessive correction. To obtain the desired correction, it is necessary to limit this pressure increase. This is obtained very simply by increasing the volume of the chamber V_3 by means of the diaphragm 27. Indeed, it has already been seen that the chambers V_2 and V_3 are filled with air at the atmospheric pressure and temperature of the region in which the carburation is regulated. Two cases are to be considered:

(1) Variation in atmospheric pressure in chamber V_4 at constant temperature.

(2) Variation in the temperature at constant atmospheric pressure.

In the first case, if the atmospheric pressure in the chamber V_4 diminishes, which occurs when ascending a mountain, there is a pressure difference between the chamber V_3 and V_4 , the pressure in V_4 being lower than in V_3 . The diaphragm 27 moves more or less in accordance with the stiffness of the spring 29 opposing its movement and this results in an increase in the volume of the chamber V_3 and consequently a decrease in the pressure. Now, as the pressure in the chamber V_3 is the same as that in the chamber V_2 , the action of the pressure on the diaphragm 19 would be weaker and the correction of the fuel flow would be weaker.

In the second case, if the temperature increases while the atmospheric pressure remains unchanged, the pressure due to the temperature increase in the chamber V_2 would be lower than if this chamber V_3 were indeformable. The correction of the flow would also be weaker.

Thus, it is possible to vary the fuel flow correction at will on acting on the stiffness of the springs 28 and 29.

Although specific embodiments of the invention have been described, many modifications and changes may be made therein without departing from the scope of the invention as defined in the appended claims.

The volumetric pump could be of any type other than that described.

Having now described my invention what I claim as new and desire to secure by Letters Patent is:

1. Device for regulating a fuel injection pump for an internal combustion engine, said device comprising a wall defining the induction pipe of the engine, a first chamber, a flexible diaphragm partly defining the chamber and operatively connected to an element of the injection pump controlling the flow of fuel from the latter so that movement of the diaphragm varies the fuel flow, the said wall defining induction pipe including a wall portion defining a Venturi having a neck portion, an air entry regulating throttle located in the neck portion, a first aperture in that part of said wall portion defining said neck portion of the Venturi, a second aperture in said wall in a position downstream of the Venturi relative to the fluid flow through the induction pipe, and means putting the chamber in communication with simultaneously the first aperture and the second aperture, the position of the first aperture being such that the first aperture is wholly on the downstream side of the throttle in the idle speed position of the throttle whereas a part of the first aperture is on the upstream side of the throttle when the throttle occupies a position corresponding to the beginning of an acceleration of the engine and wholly exposed to the suction prevailing in said neck portion in the fully open position of the throttle.

2. Device for regulating a fuel injection pump for an internal combustion engine as a function of the suction prevailing in the induction pipe of the engine, said device comprising a first chamber, a flexible diaphragm partly defining the chamber and operatively connected to an ele-

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ment of the injection pump controlling the flow of fuel from the latter so that movement of the diaphragm varies the fuel flow, the induction pipe including a portion in the shape of a Venturi, an air entry regulating throttle located in the neck of the Venturi portion, a first aperture in the neck of the Venturi portion of the induction pipe, a second aperture in the induction pipe on the downstream side of the Venturi relative to the fluid flow through the induction pipe, and means putting the chamber in communication with the first and second apertures, the position of the first aperture being such that the first aperture is wholly on the downstream side of the throttle in the idle speed position of the throttle whereas a part of the first aperture is on the upstream side of the throttle when the throttle occupies a position corresponding to the beginning of an acceleration of the engine, the throttle being mounted to be rotatable about an axis extending transversely of said induction pipe and the first aperture having a substantially elongated arcuate shape centered on said axis.

3. Device for regulating a fuel injection pump for an internal combustion engine as a function of the suction prevailing in the induction pipe of the engine, said device comprising a first chamber, a flexible diaphragm partly defining the chamber and operatively connected to an element of the injection pump controlling the flow of fuel from the latter so that movement of the diaphragm varies the fuel flow, the induction pipe including a portion in the shape of a Venturi, an air entry regulating throttle located in the neck of the Venturi portion, a first aperture in the neck of the Venturi portion of the induction pipe, a second aperture in the induction pipe on the down-

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stream side of the Venturi relative to the fluid flow through the induction pipe, means putting the chamber in communication with the first and second apertures, the position of the first aperture being such that the first aperture is wholly on the downstream side of the throttle in the idle speed position of the throttle whereas a part of the first aperture is on the upstream side of the throttle when the throttle occupies a position corresponding to the beginning of an acceleration of the engine, a second chamber partly defined by the side of the diaphragm opposed to that partly defining the first chamber, a third chamber, a second flexible diaphragm partly defining the third chamber, means putting the second and third chambers in communication with each other and isolating the second and third chambers from the atmosphere, means putting the face of the second diaphragm opposed to the face thereof partly defining the third chamber in communication with the atmosphere, two antagonistic first resiliently yieldable means respectively in pressure applying relation to the two faces of the first diaphragm, and two antagonistic second resiliently yieldable means respectively in pressure applying relation to the two faces of the second diaphragm which is in equilibrium between said second resiliently yieldable means.

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