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Okura et al.

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[54] **APPARATUS FOR COMPENSATION OF THE OPERATION OF A NEGATIVE PRESSURE CONTROL TYPE FUEL INJECTION APPARATUS**

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[52] **U.S. Cl.**.....**123/140 MP,** 123/140 MC, 123/139 AW

[51] **Int. Cl.**.....**F02d 1/06,** F02m 51/00

[58] **Field of Search**.....123/140 MP, 140 MC, 123/139 AB, 139 AC, 139 AK, 139 BG, 139 AY, 140, 139

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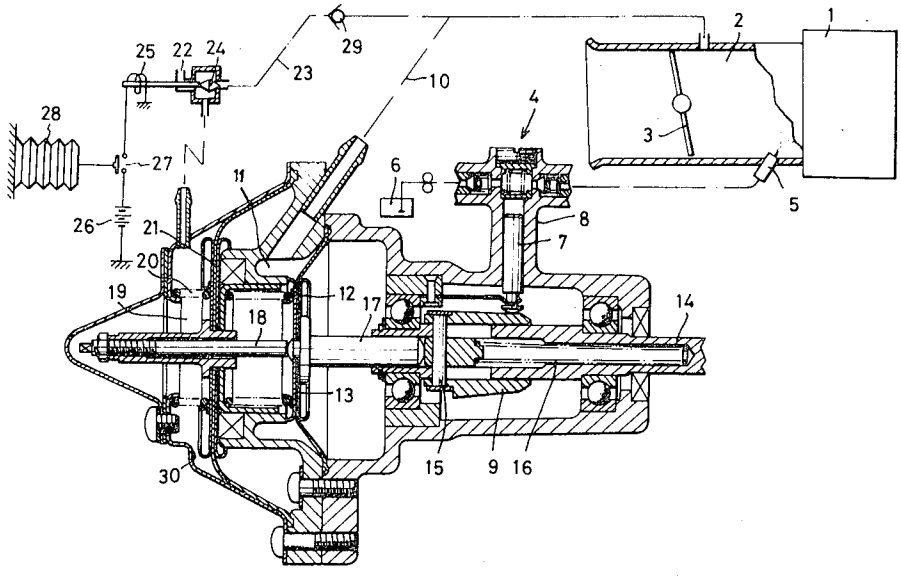
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[57] **ABSTRACT**

An apparatus of the type in which the amount of fuel injected to an internal combustion engine is controlled by a control member arranged to be moved with a front wall urged forwardly by a return spring and rearwardly by negative pressure in a negative pressure chamber connected to an air intake passage of the internal combustion engine. A second negative pressure chamber is provided behind the foregoing negative pressure chamber and the foregoing return spring is supported by a second front wall, which is urged forward by a second return spring in the second negative pressure chamber, the interior of the second negative pressure chamber being selectively connected to the atmosphere and the air intake passage of the engine through a change-over valve.

9 Claims, 2 Drawing Figures



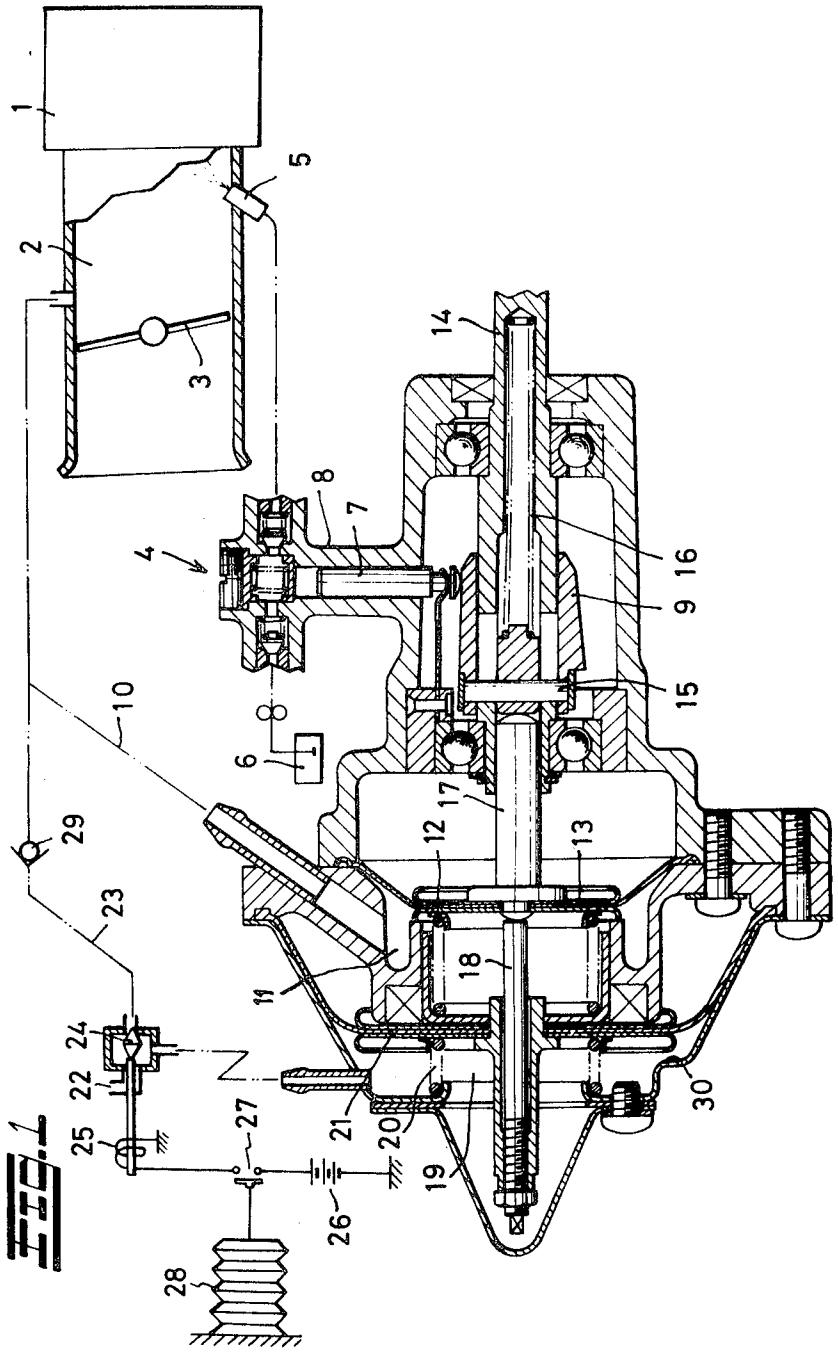


FIG. 1

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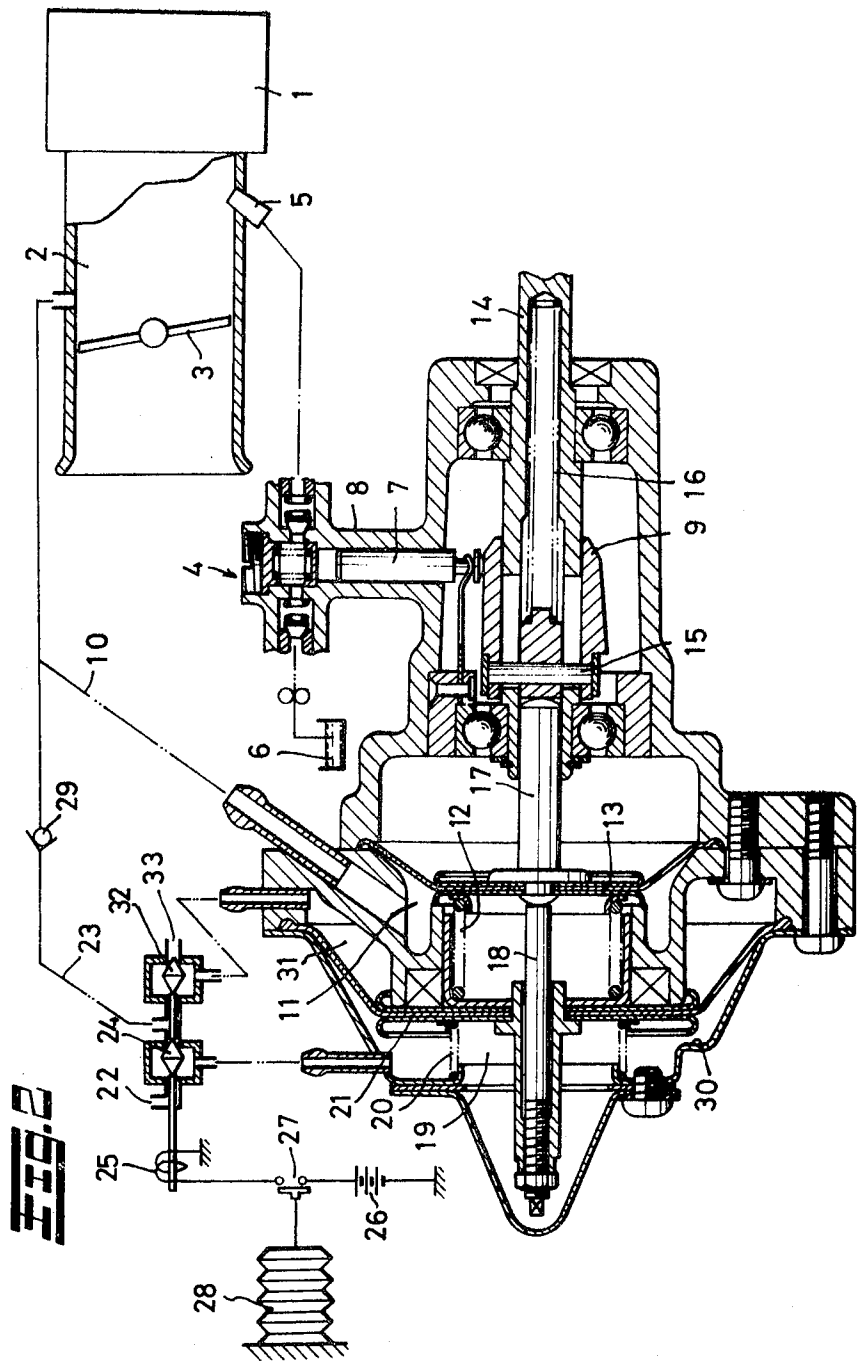


FIG. 2

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APPARATUS FOR COMPENSATION OF THE OPERATION OF A NEGATIVE PRESSURE CONTROL TYPE FUEL INJECTION APPARATUS

BRIEF SUMMARY OF THE INVENTION

This invention relates to a negative pressure control type fuel injection apparatus for a fuel injection type internal combustion engine.

An object of the invention is to provide control means in such apparatus to compensate for lowering of atmospheric pressure to obtain constant air-fuel mixing ratio.

According to the invention, in an apparatus of the type in which a fuel injection control member is arranged to be moved with a front diaphragm wall subjected to the forward action of a return spring, and the rearward action of negative pressure in a chamber connected to an air intake passage of an internal combustion engine, there is provided a second negative pressure chamber behind the first chamber, and said return spring is supported at the rear surface thereof by a second wall, which is urged forward by a second return spring in the second negative pressure chamber, the interior of the second negative pressure chamber being selectively connected to the atmosphere and to the interior of the air intake passage of the engine through a change-over valve.

In further accordance with this invention, a third negative pressure chamber is provided in front of the second wall, and the third chamber is selectively connected to the atmosphere and the air intake passage through a second change-over valve in reverse phase relation to the second negative pressure chamber.

According to a further feature of this invention, a conduit connecting the second negative pressure chamber and the air intake passage has a check valve interposed therein.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a sectional side view of one embodiment according to this invention; and

FIG. 2 is a sectional side view of another embodiment of the invention.

DETAILED DESCRIPTION

Referring to the drawing, numeral 1 denotes an internal combustion engine, numeral 2 denotes an air intake passage connected thereto, and numeral 3 denotes a throttle valve provided therein. The air intake passage 2 is provided with a fuel injection nozzle 5 connected to the outlet of a fuel injection apparatus 4, whereby the engine 1 is constituted as a fuel injection type engine. Numeral 6 denotes a fuel tank connected through a feed pump to the inlet of the injection apparatus 4.

The injection apparatus 4 comprises a plunger type injection pump 8 having a reciprocating plunger 7, and a control member 9 for controlling the stroke of the reciprocating plunger 7, the control member 9 being movable forward and rearward to control the amount of fuel which is injected. The control member 9 is moved by a diaphragm type front wall 13 of a negative pressure chamber 11. The wall 13 is urged forward by a return spring 12. The negative pressure chamber 11 is connected through a conduit pipe 10 to the interior of the air intake passage 2 of the engine 1.

The control member 9 comprises a rotary drum cam gradually increased in cam height from one end to the other. The control member 9 is mounted on a tube shaft 14 driven by the engine 1 and is slidably engaged therewith through a diametric pin 15. At the pin 15, the control member 9 is subjected to the action of a front spring 16 and a rear push member 17 projecting from the front wall 13 so that the control member 9 can be moved in response to the intake negative pressure in the air intake passage 2. Accordingly, if the intake negative pressure is increased, the front wall 13 is retracted as illustrated, so that the control member 9 is also retracted therewith and the stroke of the plunger 7, and, consequently, the amount of the fuel injected by the pump 8 is decreased. If, however, the intake negative pressure is decreased, the front wall 13 is advanced, so that the control member 9 is also advanced therewith and the stroke of the plunger 7, and consequently, the amount of the fuel injected by pump 8 is increased. Numeral 18 denotes a stopper for limiting the retractive movement of the front wall 13.

The above described construction is not especially different from conventional arrangements. According to the invention, there is provided apparatus such that when, for example, the atmospheric pressure is lowered, the control operation can be compensated in response thereto. This apparatus is described hereafter.

A second negative pressure chamber 19 is provided behind the negative pressure chamber 11, and the return spring 12 is supported at its rear surface by a diaphragm type front wall 21, which is urged forward by a return spring 20 in the second negative pressure chamber 19. The interior of the chamber 19 is selectively connected to an opening 22 connected to the atmosphere and a conduit 23 connected to the interior of the air intake passage 2 of the engine 1 through a change-over valve 24. The change-over valve 24 is, in the ordinary case, moved to the right to provide communication between the interior of the negative pressure chamber 19 and the atmosphere, but when a solenoid 25 is energized the valve 24 is moved to the left to provide communication between the interior of the negative pressure chamber 19 and the interior of the air intake passage 2. A switch 27 is interposed in a circuit connecting the solenoid 25 and an electric source 26, and the switch is closed by the operation of a detecting device 28 sensitive to the lowering of atmospheric pressure. The conduit 23 is provided with a check valve 29 so that during the operation of the second negative pressure chamber 19, it will not become inoperative by the change in the negative pressure caused by opening of the throttle valve 3. Numeral 30 denotes a stop for limiting the retractive movement of the front wall 21.

The operation of the apparatus is as follows:

In the ordinary case, the interior of the second negative pressure chamber 19 is in communication with the atmosphere and is kept at atmospheric pressure, so that the front wall 21 is pushed by the return spring 20 and is kept in its predetermined advanced position. Thereby the front return spring 12 is in a regular compressed condition, and the control member 9 operates in accordance with the intake negative pressure of the engine under a comparatively strong spring force of the return spring 12. If, however, the atmospheric pressure is lowered substantially, for example, at high elevation such as in mountains or the like, and the change-over valve 24 is moved to the left, the interior of the negative pressure chamber 19 is brought into communication with the interior of the air intake passage 2 and is

subjected to the large negative pressure thereat, so that the front wall 21 is retracted against the action of the return spring 20, and accordingly the rear support surface of the front return spring 12 is retracted and the spring 12 is increased in length and is weakened in its spring force. Thus, the control member 9 is subject to the condition in which the control member 9 is moved in accordance with the intake negative pressure under a weaker spring force of return spring 12. Consequently, the amount of fuel injection is comparatively easily decreased thus compensating for the decrease in the air density in proportion to the degree of lowering of the atmospheric pressure.

Thus, according to this invention, compensation corresponding to lowering of atmospheric pressure can be easily obtained in that the return spring cooperating with the control member is varied between a condition of comparatively strong spring force and a condition of comparatively weak spring force, and such a change is effected simply by connecting the interior of the second negative pressure chamber to the interior of the air intake passage of the engine by the operation of the change-over valve 24; the operation is smooth and accurate and the construction is simple.

In the foregoing example, in order for the diaphragm type front wall 21 to be kept in its advanced position, the rear side spring 20 must be comparatively strong. When, accordingly, the front wall 21 is to be retracted by applying the intake negative pressure to the rear side negative pressure chamber 19, the negative pressure must be large enough to overcome the force of the spring 20. However, when the intake negative pressure is comparatively small, the front wall 21 may not be affected thereby and the compensation for the atmospheric pressure may not be correctly effected.

FIG. 2 shows an embodiment which avoids this possibility. In this embodiment, there is provided a third negative pressure chamber 31 at the periphery of the front wall 21, and the chamber 31 is selectively connected to an opening 33 connected to the atmosphere or the conduit pipe 23 connected to the air intake passage 2, through a second change-over valve 32 moving with the change-over valve 24. In this arrangement, the second change-over valve 32 is arranged to operate in reverse phase relation to the change-over valve 24, and therefore the third negative pressure chamber 31 is connected to the atmosphere and to the air intake passage 2 in reverse phase relation to the second negative pressure chamber 19. Thus, when the second negative pressure chamber 19 is connected to the atmosphere as illustrated, the third negative pressure chamber 31 is connected to the interior of the air intake passage 2, and thereby the front wall 21 is biased forwardly by the atmospheric pressure at the rear and by the negative pressure at the front and thus the rear surface spring 20 may be made comparatively weak. When the second negative pressure chamber 19 is connected to the interior of the air intake passage 2, the third negative pressure chamber 31 is connected to the atmosphere air, so that the front wall 21 is biased rearwardly by the rear negative pressure and the front atmospheric pressure. Thus, even with a comparatively small intake negative pressure, the front wall 21 can be displaced and the atmospheric pressure compensation can be properly effected.

What is claimed is:

1. In apparatus for the control of the amount of fuel injection to an internal combustion engine by the displacement of a control member under the action of a diaphragm wall subjected to the negative pressure in an air intake passage leading to the engine and a return spring, an improvement comprising displaceable means supporting the return spring, and means for moving said displaceable means in response to change in atmospheric pressure to vary the effect of the action of the return spring on the diaphragm wall, said displaceable means including a movable wall against which the return spring bears, said means for moving the displaceable means comprising a negative pressure chamber in communication with said movable wall, and means for selectively connecting said negative pressure chamber to the air intake passage and to atmosphere.

2. Apparatus as claimed in claim 1 wherein the means for selectively connecting the negative pressure chamber to the air intake passage and to atmosphere comprises a change-over valve.

3. Apparatus as claimed in claim 2 comprising a check valve between the change-over valve and the air intake passage.

4. Apparatus as claimed in claim 2 wherein said means for selectively connecting the negative pressure chamber to the air intake passage and to atmosphere further comprises a pressure-sensitive means responsive to atmospheric pressure and coupled to the change-over valve for moving the same from a first position in which the change-over valve connects the negative pressure chamber to the air intake passage to a second position in which the change-over valve connects the negative pressure chamber to the atmosphere.

5. Apparatus as claimed in claim 4 wherein said pressure sensitive means comprises a solenoid acting on the change-over valve, a switch controlling energization of the solenoid and a detector sensitive to atmospheric pressure reduction and coupled to the switch to control opening and closing thereof.

6. Apparatus as claimed in claim 2 comprising a second return spring acting on said movable wall to urge the same to a forward position tending to intensify the action of the first return spring on the diaphragm wall.

7. Apparatus as claimed in claim 6 comprising means acting in concert with the second return spring to reduce the strength required for said second return spring.

8. Apparatus as claimed in claim 7 wherein the means acting in concert with the second return spring comprises a second negative pressure chamber in communication with the movable wall on a side thereof opposite the first negative pressure chamber, a second change-over valve selectively connecting the second chamber with the atmosphere and the intake passage, and means connecting the two change-over valves for operation of the first and second chambers in reverse phase relation.

9. Apparatus as claimed in claim 8 wherein said second chamber is at the periphery of the first chamber.

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