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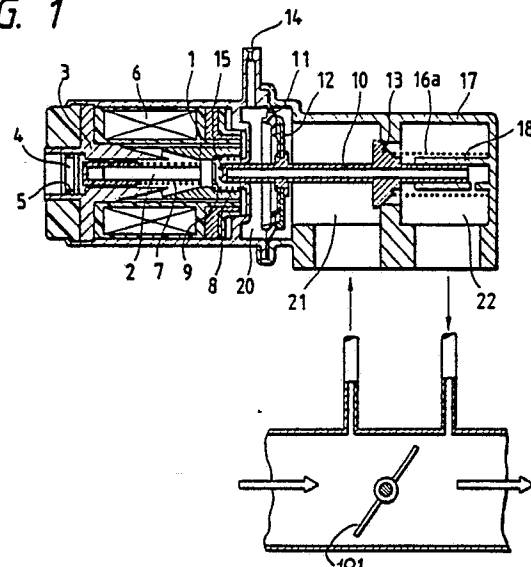
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An idling engine speed control valve and a method of improving characteristics thereof.

An idling engine speed control valve has an electromagnetic coil (6), a plunger (1) adapted to be attracted to the electromagnetic coil, a spring (7) urging the plunger so as to apply thereto a force balancing with the attractive force of the electromagnetic coil, a pilot valve seat (9) provided on an end surface of the plunger, a hollow shaft (10) formed separately from the plunger with a main valve (13) and a diaphragm (11) mounted fixedly thereon, and a pilot valve (15) formed at one end of the hollow shaft so as to be opposed to the pilot valve seat. The hollow shaft is supported so that it can be slid in the axial direction thereof, and the end of the hollow shaft carrying the pilot valve (15) is in contact with the diaphragm and positioned in a chamber (20) communicating with the atmosphere via an orifice (14), the end of the hollow shaft which is on the opposite side of the pilot valve-carrying end thereof communicating with the portion of a throttle unit which is on the downstream side of a throttle valve (101). The control valve has a means, for example spring (16a;16b), for applying to the main valve a

force large enough to fill any diminution of valve opening force in an engine starting operation under low-temperature conditions.

FIG. 1



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AN IDLING ENGINE SPEED CONTROL VALVE AND A METHOD OF IMPROVING CHARACTERISTICS THEREOF

BACKGROUND OF THE INVENTION

This invention relates to an idling engine speed control valve for controlling the idling of an internal combustion engine for an automobile, and more particularly to a method of improving the characteristics of an idling engine speed control valve with respect to the time of the starting of an engine.

Figure 4 of the accompanying drawings is a sectional view of a conventional idling engine speed control valve. Referring to Figure 4, when an electric current is applied to an electromagnetic coil 6 (which will hereinafter be referred to as a coil), a plunger 1 is moved to the left (as viewed in Figure 4). A shaft 2 is fixed to the plunger 1 and urged to the right (as shown in Figure 4) by a spring 7. A core 3 for the coil 6 supports an adjusting screw 4 for restricting the stroke of the shaft 2, the screw head being sealed in a bore by an O-ring 5. The right hand end surface (shown in Figure 4) of the plunger 1 is concave and is provided with a pilot valve seat 7 via the shaft 2. A spring 8 urges the plunger 1 to the left in Figure 4. Separately from the plunger 1, a hollow shaft 10 is provided so that the hollow shaft 10 can be slid coaxially with the plunger 1.

The right hand end in Figure 4 of the hollow shaft 10 is disposed in a chamber 22 of a body 17, and the chamber 22 communicates with the portion of a throttle unit in a carburetor located on the downstream side of a throttle valve 101. A guide 18 is provided for the hollow shaft 10. A main valve 13 is fixed on the hollow shaft 10 and positioned between the chamber 22 and a chamber 21 which communicates with the portion of the throttle unit which is on the upstream side of the throttle valve 101. The hollow shaft 10 also supports a diaphragm 11 via a plate 12, and the diaphragm 11 defines the chamber 21 and a diaphragm chamber 20. The diaphragm chamber 20 communicates with the atmosphere via an orifice 14.

At the left hand end of Figure 4, a pilot valve 15 is formed on the hollow shaft 10. The pilot valve 15 is positioned in the diaphragm chamber 20 and opposed to the pilot valve seat 9.

The operation of such a conventional idling engine speed control valve will now be described.

First, when the engine is started with an electric current not applied to the coil 6, the plunger 1 is pressed to the right as shown in Figure 4 due to the balancing movements of the springs 7, 8 and motion is limited owing to the engagement of the pilot valve seat 9 and pilot valve 15 with each

other. The pilot valve 15 in this condition is fully closed, and the diaphragm chamber 20 is at an atmospheric pressure through the orifice 14. The pressure in the chamber 21 from which the air flows into the body 17 is also closed to atmospheric pressure. Therefore, the pressures in the chambers on the front and rear sides of the diaphragm 11 do not substantially differ, so that a force does not occur on the diaphragm 11. A difference between the pressures on the front and rear sides of the main valve 13 occurs due to the suction vacuum of the engine applied to the chamber 22 on the air discharge side, and constitutes a difference between the pressures in the chambers 21, 22. This differential pressure is about 500mmHg in a normal idling condition, and works as a force for closing the main valve 13.

When an electric current is applied to the coil 6, so that the coil is excited, a magnetic field occurs and a force for moving the plunger 1 is generated. This attractive force causes the plunger 1 to be moved to the left, so that the valve seat 9 leaves the pilot valve 15. Due to the disengagement of the valve seat 9 from the pilot valve 15, the vacuum on the downstream side of the throttle valve 101 is applied to the diaphragm chamber 20 to cause the diaphragm 11 to be moved to the left.

Thus, the hollow shaft 10 and main valve 13 mounted fixedly thereon are driven by the plunger 1 as the driving force of the plunger 1 is increased doubly by the force of the differential pressure applied to the diaphragm 11. However, when starting engine speed is low, for example, under low-temperature conditions, for example 0°C or less, a sufficiently large difference does not occur between the pressures in the chamber 21 and diaphragm chamber 20 in this prior art valve. Therefore the force for opening the main valve 13 produced by the diaphragm 11 is not sufficient and it becomes impossible to obtain desired idling engine speed control characteristics.

When the engine is started at a low temperature, the capacity of a battery lowers, and the quantity of electric current supplied to the coil 6 decreases, so that the electromagnetic attractive force of the plunger 1 decreases. Consequently, the degree of opening of the main valve 13 correspondingly decreases. When the degree of opening of the main valve 13 becomes lower, a proper fuel-air ratio cannot be obtained, and this causes a failure in an engine starting operation.

In order to eliminate the inconveniences encountered in an operation of the conventional idling engine speed control valve under the low-tempera-

ture conditions, a flow rate control valve constructed so that a main valve can be kept slightly open while an electric current is not applied to a coil, for the purpose of preventing the freezing of the idling engine speed control valve has been proposed (Japanese Patent Laid-open No. 120872/1981). However, no method and apparatus for improving the characteristics of an idling engine speed control valve with respect to the time of starting an engine have yet been proposed.

The present invention has been developed in view of the above-mentioned facts. An object of the present invention is to provide a method of improving the characteristics of an idling engine speed control valve so as to eliminate the difficulties in starting an engine under low-temperature conditions, i.e. so as to enable an engine to be suitably started under low-temperature conditions, e.g. at or below 0°C; and an idling engine speed control valve having improved characteristics with respect to the starting of an engine under low-temperature conditions.

SUMMARY OF THE INVENTION

In a method according to the present invention developed with a view to achieving this object, a valve opening force is applied to a main valve in an idling engine speed control valve. This force may be permanent and can be constant but it is not, of course, so large that it disturbs the normal operation of each part but is large enough to ensure that the valve opening force is sufficient at the time of starting the engine under low-temperature conditions. In comparison with the above-mentioned known techniques (Japanese Patent Laid-open No. 120872/1981) in which the force of the springs is balanced so as to keep the main valve slightly open when an electric current is not supplied to the coil, for the purpose of preventing the freezing of the idling engine speed control valve, the method according to the present invention consists of the step of applying a small force (auxiliary valve opening force) to the main valve in the valve opening direction constantly and one-sidedly.

An idling engine speed control valve according to the present invention developed for practicing the above-described method according to the present invention is provided with a means (for example, a coiled compression spring) for applying a force to the main valve in the valve opening direction. This valve opening force is a one-sided auxiliary force, and this valve opening force applying means does not have a structure for restricting the position of the main valve by a force balancing operation.

When the engine is started at a low tempera-

ture, the capacity of the battery lowers to cause the torque of the coil solenoid to decrease, and the viscosity of the lubricating oil increases to cause the starting engine speed to decrease. Consequently, a differential pressure applied to the diaphragm in the idling engine speed control valve decreases, so that the valve opening force decreases.

Due to a decrease of the capacity of the battery, the electromagnetic attractive force of the coil decreases, and the valve opening force further decreases.

When an auxiliary valve opening force is applied to the main valve by utilizing the method according to the present invention, the valve opening effect is promoted. As a result, the main valve is opened, and a required quantity of combustion air is supplied.

In the idling engine speed control valve according to the present invention, an auxiliary valve opening force is applied to the main valve by, for example, a coiled compression spring exerting a constant force. Accordingly, any diminution of the valve opening force when the engine is started at a lower temperature is overcome, and a proper flow rate of combustion air can be obtained. This enables a proper fuel-air ratio to be obtained, and a rate of success of an engine starting operation to be markedly improved.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a sectional view of an embodiment of the idling engine speed control valve according to the present invention;

Figure 2 is a graph for use in describing the operation and effect of this embodiment;

Figure 3 is a sectional view of another embodiment; and

Figure 4 is a sectional view of a prior art idling engine speed control valve.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Figure 1 is a sectional view of an embodiment of the idling engine speed control valve according to the present invention constructed by utilizing the valve characteristic improving method in accordance with the present invention.

The embodiment of Figure 1 is an improvement on the prior art conventional example shown in Figure 4, which improvement is obtained by applying the concept of the present invention thereto. The parts, which are designated by the same reference numerals as those used for the prior art, of this embodiment represent constituent

parts identical with or similar to those of the conventional example. Accordingly, the descriptions of the parts of this embodiment, which are identical with or similar to those shown in Figure 4, will be omitted.

The differences between this embodiment and the prior art (Figure 4) will now be described. The present invention is made by adding a coiled spring 16a to the structure shown in Figure 4, this spring 16a being inserted in a compressed state between the main valve 13 and body 17 so as to urge the main valve 13 in the valve opening direction (leftward in Figure 1).

The valve opening force in an engine starting operation under the low-temperature conditions, e.g. 0 °C or below, tends to diminish for the above-mentioned reasons but, when the diminution of the valve opening force is a low-temperature engine starting operation is compensated by the force of the coiled spring 16a, the main valve 13 can be opened even in an engine starting operation under such low-temperature conditions. The spring 61a exerts a permanent force which may be arranged to be constant.

Figure 2 is a valve characteristic diagram in which the rate of supplying an electric current to the coil 6 in the Figure 1 embodiment is taken in the direction of the horizontal axis with the valve opening stroke concerning the main valve 13 taken in the direction of the vertical axis. This diagram shows three lines with the vacuum on the downstream side of the throttle valve used as a parameter.

(i) -67 KPa (gauge pressure) corresponding to an idling operation under regular (normal) conditions is shown by a solid line.

(ii) -27 KPa (gauge pressure) corresponding to a starting operation under regular conditions is shown by a broken line.

(iii) OPa showing ultimate conditions in which the starting conditions are bad with the temperature at a low level is shown by a chain line.

This characteristic diagram clearly shows that, if an electric current is applied to the coil 6 in the idling engine speed control valve in this invention, the main valve is opened provided there is some current flow even when the differential suction pressure is ultimately low (OPa). Therefore, a starting operation can be carried out even when the temperature is low, and the shortage of the flow rate of suction air, which results in failure in a starting operation, can be prevented.

Figure 3 shows a further embodiment, different from the above-described embodiment. The differences between the first embodiment (Figure 1) and the embodiment of Figure 3 reside in that a coiled spring 16b is inserted in a compressed state between the body 17 and diaphragm 11 (plate 12)

supporting the diaphragm 11 to be exact). This embodiment also enables the same operation and effect as in the previously-described embodiment to be obtained.

As described above, when the idling engine speed control valve according to the present invention is constructed by utilizing the valve characteristic improving method according to the present invention, suitable valve characteristics are obtained in a starting operation under low-temperature conditions, and a proper flow rate of suction air even under the low-temperature starting conditions. Therefore, a proper fuel-air ratio is obtained, and a failure in a starting operation, which is ascribed to an improper fuel-air ratio, can be prevented.

Claims

1. A method of improving the characteristics of an idling engine speed control valve having an electromagnetic coil (6), a plunger (1) adapted to be attracted to said electromagnetic coil (6), a spring (7) urging said plunger so as to apply thereto a force balancing with the attractive force of said electromagnetic coil (6), a pilot valve seat (9) provided on an end surface of said plunger (1), a hollow shaft (10) formed separately from said plunger with a main valve (13) and a diaphragm (11) mounted fixedly thereon, and a pilot valve (15) formed at one end of said hollow shaft so as to be opposed to said pilot valve seat (9), said hollow shaft (10) being supported so that said hollow shaft can be slid in the axial direction thereof, the end of said hollow shaft carrying said pilot valve (15) being in contact with said diaphragm (11) and positioned in a chamber (20) communicating with the atmosphere via an orifice (14), the end of said hollow shaft (10) which is opposite said pilot valve communicating with the portion of a throttle unit which is on the downstream side of a throttle valve (101), characterized in that a force (16a;16b) is applied to said main valve (13) which is sufficient to fill any diminution of the valve opening force in an engine starting operation under low temperature conditions.

2. A method of improving the characteristics of an idling engine speed control valve according to claim 1, wherein the force is permanently applied.

3. A method of improving the characteristics of an idling engine speed control valve according to claim 1 or 2, wherein said force for overcoming said diminution of the valve opening force is generated by the resilient force of a spring (16a;16b) and applied to said main valve (13) or a member fixed thereto.

4. A method of improving the characteristics of an idling engine speed control valve as claimed in

claim 3, wherein a constant spring force is applied.

5. An idling engine speed control valve having an electromagnetic coil (6), a plunger (1) adapted to be attracted to said electromagnetic coil, a spring (7) urging said plunger so as to apply there- 5
to a force balancing with the attractive force of said electromagnetic coil (6), a pilot valve seat (9) provided on an end surface of said plunger (1), a hollow shaft (10) formed separately from said plunger (1) with a main valve (13) and a diaphragm 10
(11) mounted fixedly thereon, and a pilot valve (15) formed at one end of said hollow shaft so as to be opposed to said pilot valve seat (9), said hollow shaft (10) being supported so that said hollow shaft can be slid in the axial direction thereof, the end of 15
said hollow shaft carrying said pilot valve (15) being in contact with said diaphragm (11) and positioned in a chamber (20) communicating with the atmosphere via an orifice (14), the end of said hollow shaft (10) which is opposite said pilot valve 20
communicating with the portion of a throttle unit which is on the downstream side of a throttle valve (101), characterized by means (16a;16b) for applying a constant force to said main valve which is sufficient to overcome any diminution of valve 25
opening force in an engine starting operation under low-temperature conditions.

6. An idling engine speed control valve according to claim 5, wherein said force is permanently 30
applied.

7. An idling engine speed control valve according to claim 5 or 6, wherein said means for applying a force is a coiled spring (16a) is inserted in a compressed state between a body (17) of said control valve and said main valve (13). 35

8. An idling engine speed control valve according to claim 5 or 6, wherein said means for applying a force is a coiled spring (16b) is inserted in a compressed state between a body (17) of said control valve and said diaphragm (11). 40

9. An idling speed control valve according to claim 7 or 8, wherein said coiled spring (16a;16b) is arranged to apply a constant force. 45

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FIG. 1

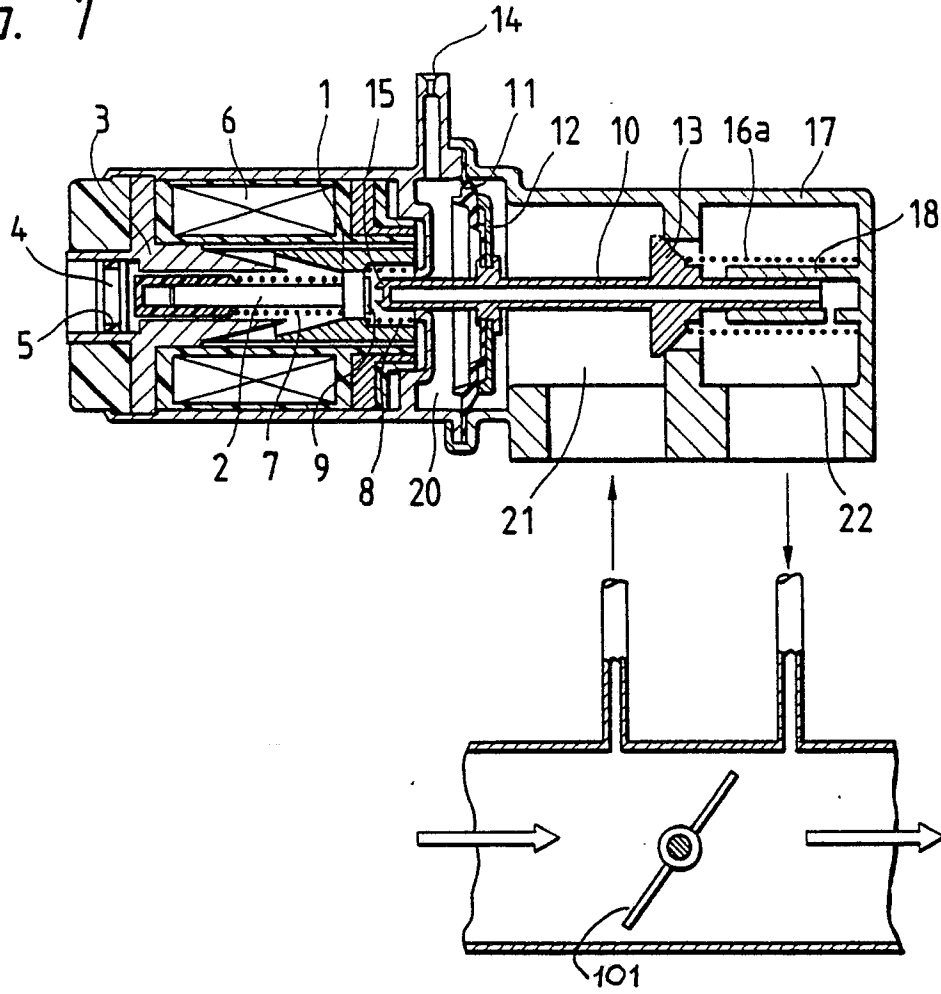


FIG. 2

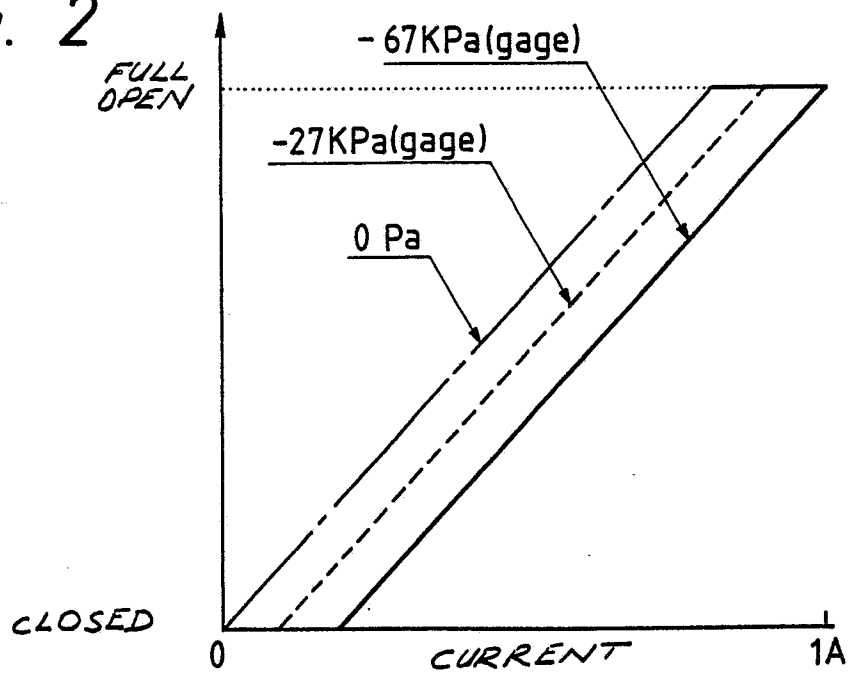
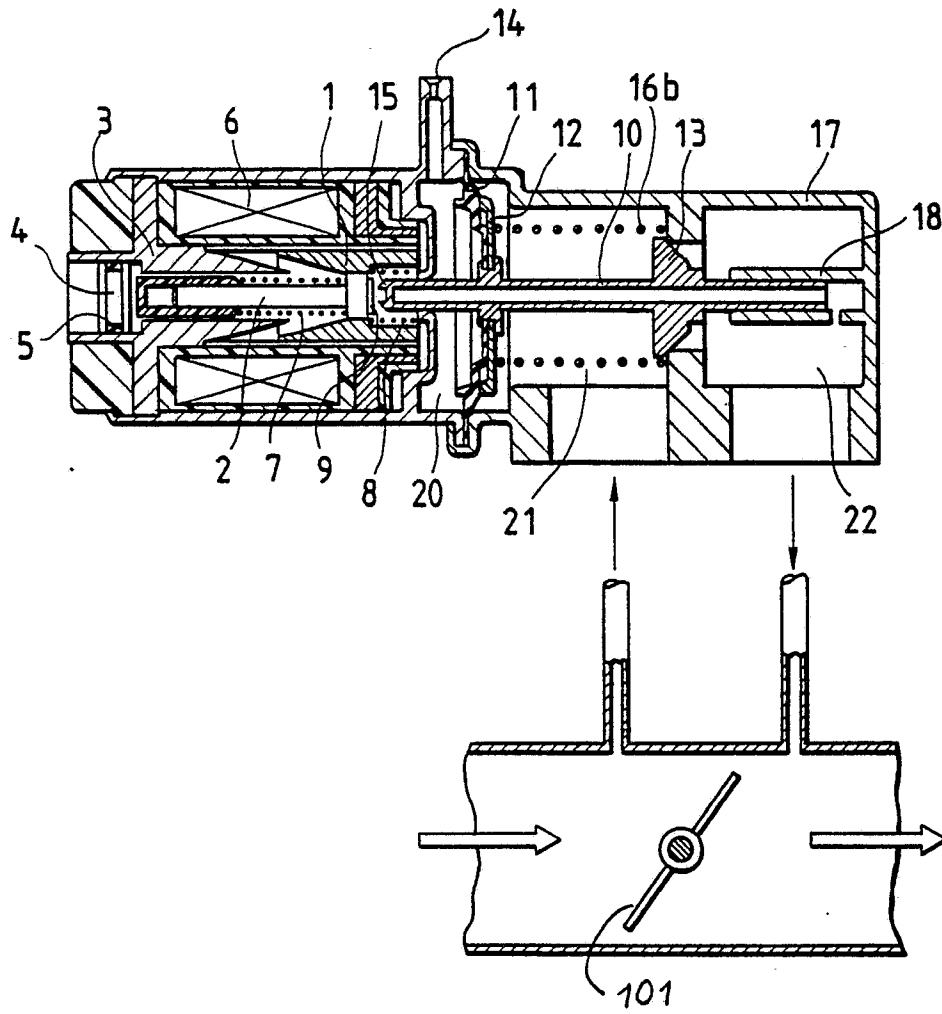


FIG. 3



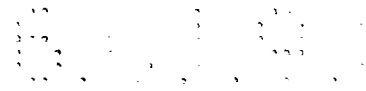


FIG. 4 PRIOR ART

