United States Patent

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[54] **MEASURING DEVICE FOR A FUEL INJECTION SYSTEM**
8 Claims, 2 Drawing Figs.

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[51] Int. Cl. **F02m 69/00**
[50] Field of Search .... 261/50 A; 123/139 AW, 119

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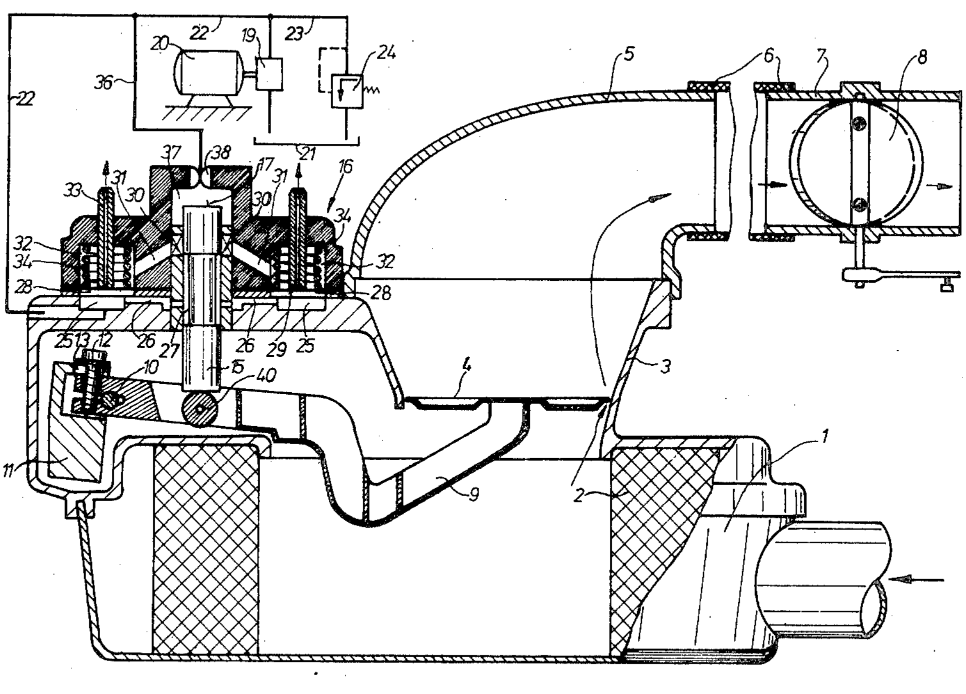
ABSTRACT: A measuring and distributing fuel valve for an external-ignition engine has a flow-responsive disc mounted in the suction duct at one end of a pivotable arm carrying a counterweight at its other end. A roller on the arm controls the rotatable slider of a measuring and distributing valve and engages frictionally with an eccentric point on the end face of the slider.



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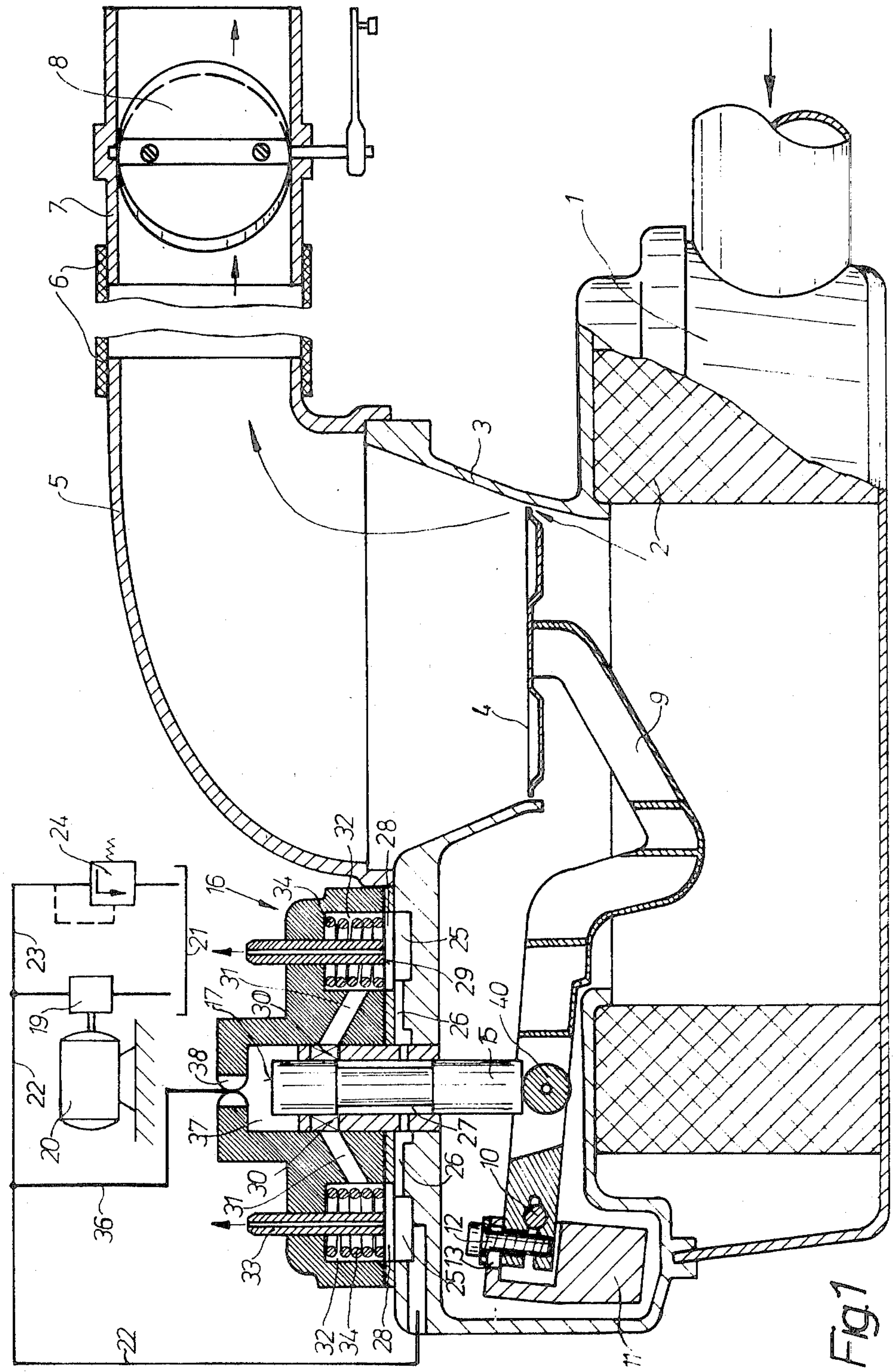

Fig.1

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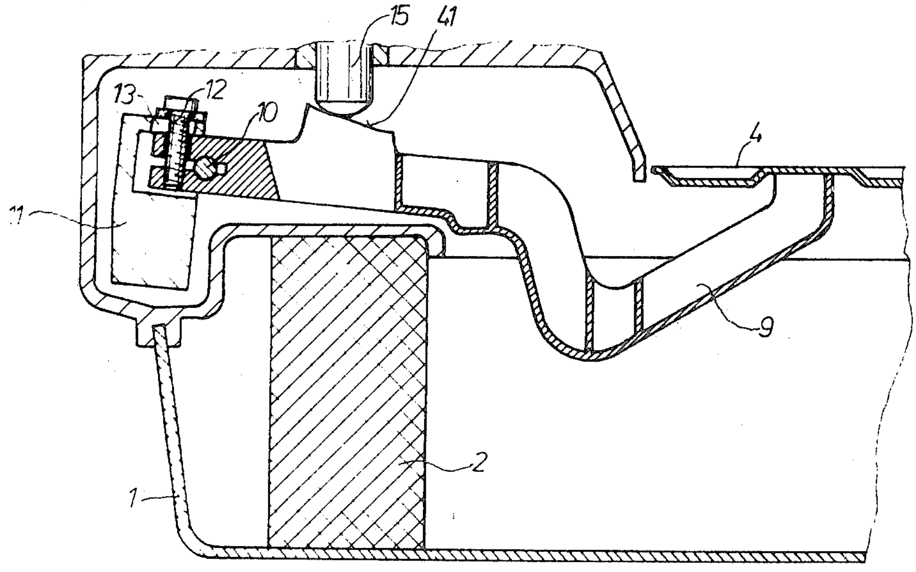

Fig. 2

MEASURING DEVICE FOR A FUEL INJECTION SYSTEM

FIELD OF THE INVENTION

The invention relates to a measuring device for a fuel injection system for external-ignition combustion engines operating with compression of the fuel mixture and with continuous injection into the suction duct.

BACKGROUND OF THE INVENTION

In a known fuel injection system of the type referred to, the measuring device and an arbitrarily adjustable throttle are provided in spaced arrangement in the suction duct, the measuring device comprising a valve disc perpendicular to the direction of airflow and subject to a return force as well as to the pressure of the airflow so as to deflect into a conically outwardly flared section of the suction duct proportionally to the rate of airflow and control the flow area of a fuel valve for measuring off an amount of fuel proportional to that of the air.

The object of this fuel injection system is to provide automatically in an Otto engine under all operating conditions a favorable fuel-to-air ratio, so as to obtain complete combustion and avoid as far as possible the generation of poisonous exhausts with the engine operating at the highest possible efficiency or with a minimum of fuel consumption. In principle, therefore, the deflection of the sensor member of the measuring device should be substantially proportional to rate of airflow in the suction duct and make possible a simple control of the measuring valve for delivering an amount of fuel that is proportional to that of the air. However, this proportionality, as well as the correct fuel-to-air ratio, is lost as soon as vibrations of the engine cause errors in the deflection of the sensor, leading, for instance, to incomplete combustion with increased fuel consumption and poisonous exhausts.

The desired proportionality is always present if the return force acting on the sensor member is constant, the flared section of the suction duct is conical and the pressure between the sensor and the throttle remains constant. To provide these desired operating conditions, it is known, according to U.S. Pat. 2,937,858, to control the measuring device by means of a pneumatically controlled hydraulic servomotor in response to the pressure difference between points in the suction duct upstream and downstream of the measuring device, this pressure difference corresponding to the rate of airflow. This rate, on the other hand, is primarily dependent on the r.p.m. of the engine and on the position of the throttle. However, the arrangement has the disadvantage that a servomotor of this type is relatively expensive.

In another fuel injection system, also having a measuring device and an arbitrarily adjustable throttle in series arrangement, an extremely weak spring is provided for exerting the return force on the sensor member, the latter being in the form of a disc which is pivotable about an axis. The capacity of this measuring device is dependent on the eccentricity of the axis; however, this eccentricity is limited by the diameter of the suction duct, so that capacity of the device is very limited.

However, the capacity has to be quite large if friction errors owing to, for instance, the friction of the distributor valve, are to be avoided.

OBJECT AND SUMMARY OF THE INVENTION

It is an object of the invention to provide an improved measuring device for a fuel injection system of the type referred to having improved capacity without requiring a complicated construction.

The essential feature of the invention is the construction of the sensor valve disc as a plate which is attached to one end of a pivotable arm. The arm is pivoted with low friction at a fixed point, the fuel valve being preferably a slide valve, the slider of which is responsive to the pivotable arm and controls at least one control notch for distributing and measuring fuel via an annular notch on the slider which is connected to the fuel supply. This immediate actuation of the slider practically eliminates mechanical play, which is of particular importance with the engine idling, since in that condition even small displacements of the slider may result in relatively large variations of r.p.m.

To minimize the influence of engine vibrations on the measuring device, in accordance with a favorable embodiment the pivotable arm is pivoted at an intermediate point thereof and carries at one end the plate and at the other end a balancing counter weight. Owing to the balancing of the masses of the plate and of the arm itself, the area of the plate can be made comparatively large and in any case appreciably larger than that of the throttle.

A further reduction of friction effects is possible in a further embodiment in which a roller on the pivotable arm engages the slider end face eccentrically so as to cause rotation of the slide valve. In a further embodiment, the pivotable arm has, at the point of engagement with the slider valve, a cam surface for varying the relationship between the deflection of the sensor and the displacement of the slider in dependence of the angular position of the arm. This may be necessary in order to eliminate deviations from the desired relationship, e.g., due to the form of the conical section of the suction duct.

To provide space for the relatively long pivotable arm as well as the sensor plate, which should preferably be comparatively large, without having to correspondingly increase the diameter of the suction duct, in accordance with a still further embodiment of the invention, the portion of the suction duct housing the sensor plate is part of a filter housing, whereby the combustion air passes through the air filter at the entrance end of the suction duct and then impinges on the sensor, where there will be under all circumstances a node of the air oscillation occurring in the suction duct. This has the further advantage of not disturbing the oscillation obtained by the tuning or proportioning of the length of the duct relative to the response intervals of the valves and the length of the exhaust tubes (ram effect).

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 shows an embodiment having a roller for transmitting the force from the pivotable arm to the slider of the fuel distributor valve.

FIG. 2 shows a modified embodiment, in which a cam is provided on the pivotable arm for engaging the slider.

DESCRIPTION OF EMBODIMENTS

In the fuel injection system of FIG. 1, combustion air flows in the direction of the arrows through an air filter 2 mounted in a housing 1, into a suction duct having a conical section 3 defining a suction space with a sensor 4 provided therein, followed by a cured section 5, a connecting tube 6, and a section 7 with an arbitrarily adjustable throttle 8 therein. Connecting to section 7 is a suction tube (not shown), from which separate conduits branch off to the cylinders of the combustion engine.

Sensor 4 comprises a plate mounted perpendicularly to the direction of airflow on a pivotable arm 9 which is mounted on a pivot 10 so as to be movable in a plane. Angular movement of arm 9 causes sensor 4 to penetrate into conical section 3, which is outwardly flared in the direction of flow. The deflection of sensor 4 is proportional to the rate of airflow, and if the return force acting of sensor 4 is constant and the air pressure obtaining ahead of it is also constant, the pressure obtaining between sensor 4 and throttle 8 will also be constant.

To compensate for the combined mass of sensor 4 and arm 9, so that it will not influence the adjustment caused by movement of sensor 4, arm 9 is pivoted at an intermediate point to provide a two-armed lever having sensor 4 at one end thereof and a compensating weight 11 at the other end. Weight 11 is attached to arm 9 by means of a screw 12 and adjustable in a slot 13.

Sensor 4 acts via arm 9 on an end face of a slider 15 of a distributor valve 16. The other end face 17 of slider 15 is subject to a constant liquid pressure acting as a return force for sensor 4.

Fuel is supplied to valve **16** by a fuel pump **19**, which is driven by an electric motor **20** and draws fuel from a container **21** and supplies it to valve **16** through a fuel line **22**. A return line **23** branches off from line **22** and has provided therein a pressure limiting relief valve **24**.

The fuel flows from line **22** into an annular notch **25** provided in the housing of distributor valve **16**. Notch **25** connects, on the one hand, via channels **26** with an annular notch **27** of slider **15** and, on the other hand, with a number of chambers **28** which are bounded by a diaphragm **29**. Diaphragm **29** is therefore subject to the pressure of the supplied fuel. Depending on the position of slide valve **15**, annular notch **27** overlaps to a greater or lesser extent a number of control notches **30**, which connect via channels **31** with corresponding chambers **32** on the opposite side of diaphragms **29** relative to chambers **28**.

From chambers **32** the fuel flows via outlets **33** to the individual injection valves, not shown, which are provided in the suction duct close to the engine cylinders. Diaphragm **29** serves as the movable valve member of a flat seat valve, which is, in normal operation, held open by a spring **34**. Chambers **28** and **32** act as diaphragm chambers which guarantee that the pressure drop ahead of and after the measuring points **27** and **30** remains constant independently of the degree of overlap between notch **27** and notches **30**, i.e., independently of the amount of fuel flowing to the injection valves. This ensures the proportionality between the displacement of slide valve **15** and the measured-off fuel quantity.

The liquid serving to provide a constant return force on slider **15** is also fuel. To this end, a line **36** is provided to branch off from line **22** into a space **37**, into which extends the end **17** of slider **15**. In line **36**, a restriction **38** is provided for damping the movement of slider **15**. The pressure of the return force liquid can be varied by means not shown so as to change the factor of proportionality defining the fuel-to-air ratio. The embodiments of FIGS. **1** and **2** differ merely in the transmission of the force from arm **9** to slider **15**. In FIG. **1**, there is provided a roller **42** attached to arm **9**. The roller may be located so as to engage the end face of slider **15** eccentrically and to cause in response to the movement of arm **9** not only an axial but also a rotational movement of slider **15**, whereby an extreme reduction of frictional effects is obtained.

Since, as described above, sensor **4** penetrates into a conical section **3** of the suction duct, and the annular space between it and the conical wall is therefore proportional to the deflection of sensor **4**, there is in this embodiment also a direct proportionality between the deflection of sensor **4** and the displacement of slider **15**. This ensures that under all conditions a proportional amount of fuel is added to the air flowing in the suction duct.

In the FIG. **2** embodiment, arm **9** translates the control movements of the sensor directly to the slide valve by means of a cam **41** provided thereon. By means of cam **41** the factor of proportionality between the deflection of sensor **4** and the displacement of slider **15** is variable. This may be necessary, for instance, for correcting errors in the fuel-to-air ratio due to throttling effects in the suction duct, since a measuring device, such as sensor **4**, which relies on flow resistance, will tend to affect the filling of the engine cylinders at higher r.p.m.'s.

That which is claimed is:

1. A measuring device for the fuel injection system of an external-ignition engine operating with compression of the fuel mixture and with continuous injection into the suction duct, comprising:

- a sensor member and an arbitrarily adjustable throttle member in longitudinally spaced arrangement in said suction duct,
- said sensor member comprising a valve disc perpendicular to the direction of flow and subject to a return force and responsive to the airflow to deflect proportionally to the rate of airflow and penetrate into a conically outwardly flared portion of said suction duct, and
- a fuel valve responsive to deflection of said sensor member to control the supply of fuel proportionally to the rate of air supply, characterized in that said valve disc comprises a plate attached to one end of a pivotable arm having a fixed pivot point of low friction.

2. A measuring device according to claim **1**, comprising a slider in said fuel valve responsive to actuation by said pivotable arm, an annular notch on said slider connected to a fuel supply for said engine for proportioning the rate of fuel supply, and at least one radial control notch connecting said annular notch with an injection nozzle.

3. A measuring device according to claim **1**, in which said arm is pivoted at an intermediate point thereof and supports at one end said disc and at the other end a counterweight.

4. A measuring device according to claim **1**, in which the area of said disc is larger than that of said throttle.

5. A measuring device according to claim **2**, in which said arm carries a roller engaging said slider.

6. A measuring device according to claim **5**, in which said slider is rotatable and said roller has frictional and eccentric engagement therewith so as to cause rotation thereof upon movement of said arm.

7. A measuring device according to claim **2**, in which said arm at the point of engagement thereof with said slider is provided with a cam for adjustment of the interrelationship between sensor member deflection and slider displacement in dependence upon angular displacement of said arm.

8. A measuring device according to claim **4**, in which said sensor disc is provided in a section of said suction duct having a filter provided therein, whereby the air after passage thereof through said filter impinges said sensor disc at the entrance to said suction duct.

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