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Eckert et al.

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[54] **FUEL INJECTION SYSTEM**

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[51] **Int. Cl.**[2] **F02M 69/00**

[58] **Field of Search** .... 123/139 AW, 142.5 R; 261/50 A; 123/142

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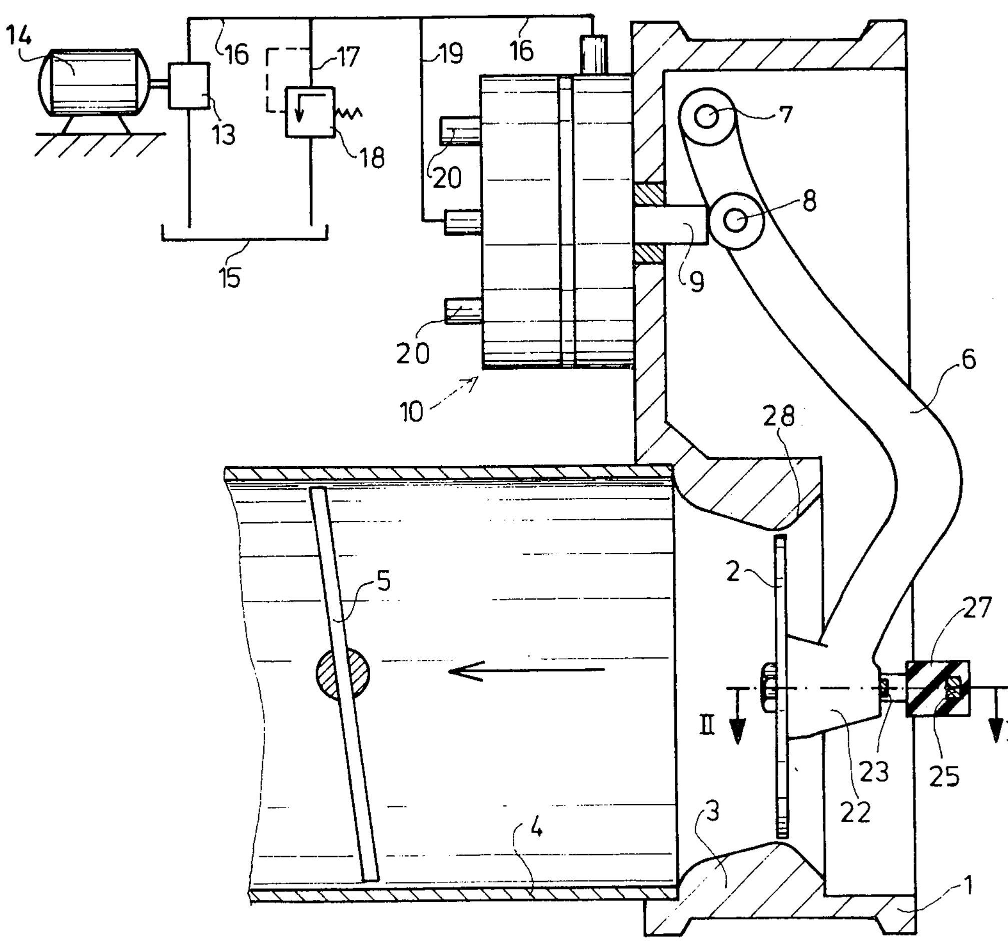
[57] **ABSTRACT**

A fuel injection system for externally ignited, gas internal combustion engines. The system is of the type which involves continuous injection into an induction tube in which a measuring member and a randomly activated throttle are arranged in series. The measuring member is embodied on a plate disposed, under quiescent conditions, at a right angle to the flow direction on one end of a pivoted lever. The plate projects proportionally to the amount of air flowing through the induction tube into a corresponding funnel-shaped section of the induction tube. The lever is operatively arranged to operate a mobile member of a valve which meters out fuel proportional to the quantity of air. The measuring member is displaced backwardly past its quiescent position, when a backfire occurs, in the induction tube, against the force of a spring having a linear characteristic and is caught by a resilient, elastic stop which converts a considerable amount of the kinetic energy into heat and returns the measuring member toward its quiescent position.

5 Claims, 2 Drawing Figures



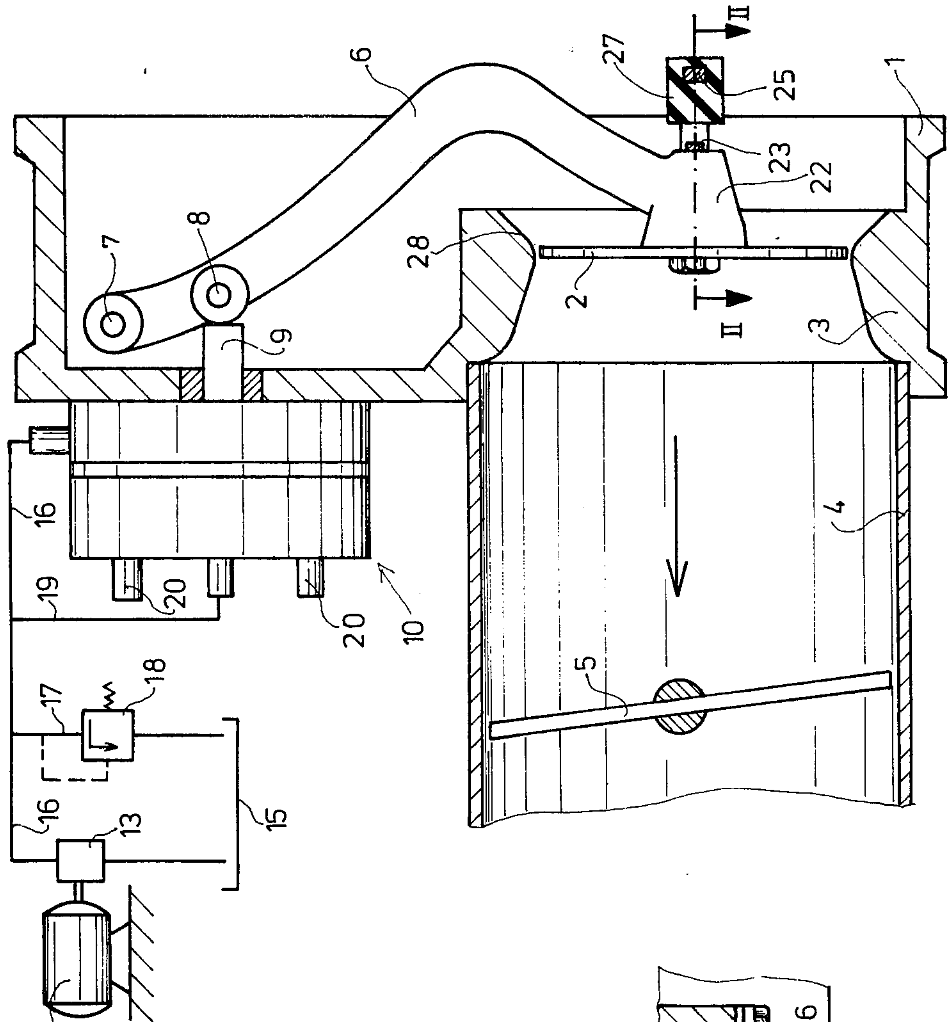


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Fig.1

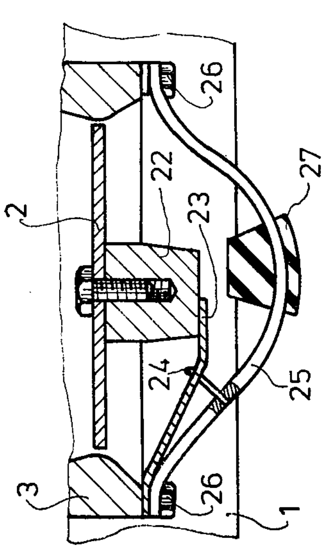

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Fig.2

FUEL INJECTION SYSTEM

BACKGROUND OF THE INVENTION

This invention relates to a fuel injection system for externally ignited, gas internal combustion engines which involve continuous injection into an induction (suction) tube (manifold) in which a measuring member and a randomly activatable throttle valve are arranged in series, more particularly, the present invention relates to such a fuel injection system in which the measuring member is operatively arranged to be displaced by a working member against a restoring force in accordance with the quantity of air flowing through. In the course of its displacement, the measuring member adjusts the movable part of a valve which is disposed in the fuel line. The movable part of the valve effects the metering out of a quantity of fuel proportional to the amount of air. The restoring force is a result of fluid which is displaced in a continuous manner under a substantially constant, but randomly variable pressure provided through a fluid pressure line. The restoring force acts on the operating member. The measuring member is embodied as a plate which is secured, at a right angle, to the direction of flow in the induction tube, to one end of a stationary pivot lever mounted in a practically friction-free manner. The measuring member projects into a corresponding funnel-shaped section of the induction tube extending in the flow direction in proportion to the quantity of air flowing through the induction tube.

Fuel injection systems of the type mentioned above are intended to provide automatically in advantageous fuel-air mixture for all operating conditions of the internal combustion engine to permit maximum combustion of the fuel thereby preventing poisonous and noxious exhaust gases from being produced, or at least to reduce considerably these gases, while obtaining maximum performance of the internal combustion engine, that is, minimum fuel consumption. The amount of fuel must therefore be very accurately proportioned to meet the requirements of every operating state of the internal combustion engine.

In the case of known internal combustion engines of this type, the quantity of air flowing through the induction tube is determined by a measuring member. The fuel is metered out in proportion to the determined quantity of air and is injected directly into the induction tube by injection valves in the proximity of each cylinder. The proportionality of the quantity of air and the amount of fuel metered out can be varied as a function of the engine operating characteristics such as the rate of revolutions, load and temperature. In the case of these known fuel injection systems, relatively high pressures are produced during backfiring which may render the system inoperable, for example, owing to sleeves or plugs springing back or out of position, or owing to damage to the measuring member or to stops.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide an improved fuel injection system in which the effect of backfiring in the induction tube is damped.

It is another object of the present invention to provide an improved fuel injection system in which operating parts are not undesirably sprung out of position as a result of backfiring.

It is a further object of the present invention to provide an improved fuel injection system in which possible damage to the measuring member during backfiring is avoided.

It is an additional object of the present invention to provide an improved fuel injection system in which possible damage to stops, which are associated with the measuring member, during backfiring is avoided.

The foregoing objects, as well as others which are to become clear from the text below, are achieved in a fuel injection system for externally ignited, internal combustion engines having means for continuously injecting combustion air into an induction tube means which includes a funnel-shaped section. A measuring member and a randomly activatable throttle valve are arranged in series within the induction tube means. The measuring member is displaceable against a restoring force by a working member in accordance with the amount of air flowing through. An adjustable mobile part of a valve is disposed in a fuel line for metering out a quantity of fuel proportional to the quantity of air, the restoring force being provided by pressure fluid which is passed in a continuous manner under constant but randomly variable pressure through a pressure line and which acts on the working member. The measuring member is embodied as a plate which is secured, in its quiescent position, at a right angle to the flow direction on one end of a pivotal lever mounted in a substantially friction-free manner. The measuring member, during engine running, projects proportionally to the amount of air flowing through the induction tube into a corresponding portion of the funnel shaped section of the induction tube means extending in the flow direction. A spring having a substantially linear characteristic is positioned in the vicinity of the measuring member for providing a force against which the measuring member must act as it passes backwardly past its quiescent position during backfiring in the induction tube means. An elastic stop means is provided behind the measuring member for arresting backward motion thereof.

In order to absorb induction tube backfiring shocks the measuring member, according to the salient feature of the present invention, is adapted to pass through its quiescent (zero) position against the force of a spring having a linear characteristic and is operatively arranged to be caught by an elastic stop.

An advantageous feature of the invention is that the elastic stop is disposed on a steel yoke rigidly connected to the induction tube.

Another feature of the invention is that the spring having a linear characteristic keeps the measuring member in its quiescent position when the fuel injection system is out of operation and in that a flat spring is used as the spring having a linear characteristic.

According to another advantageous feature of the invention, the conical portion of the induction tube and the measuring member are arranged in the air filter housing.

BRIEF DESCRIPTION OF THE DRAWING

An illustrative, exemplary embodiment of the invention is represented, in simplified form in the drawing and is to be described in further detail hereinafter.

FIG. 1 is a diagrammatic, partially sectional view of a fuel injection system, constructed in accordance with the present invention.

FIG. 2 is a sectional view of an enlarged portion of the fuel injection system of FIG. 1, the section being taken along line II—II.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

In FIG. 1 combustion air drawn for an internal combustion engine flows to one or more cylinders (not shown) of the internal combustion engine through an air filter (not shown) into an air filter housing 1 and in the direction of the arrow headed line past a measuring member 2 suspended so as to move back and forth through a funnel-shaped manifold section 3 across an induction tube section 4 in which is positioned a randomly activatable throttle valve 5. The measuring member 2 is in the form of a plate disposed at a right angle to the direction of air flow. The central portion of the measuring member 2 is attached by a bolt or other conventional fastener to a pivot lever 6 which is pivotable in a plane about a pivot point 7. The measuring member 2 is displaced within the funnel-shaped manifold section 3 according to a specific law, which represents a generally linear function of the air flowing through the induction tube section 4. The pressure between the measuring member 2 and the throttle valve 5 also remains generally constant to ensure a constant restoring force acting on the measuring member 2 and a constant air pressure in front of the measuring member 2.

The measuring member 2 acts, via the pivot lever 6 and a roller 8, directly on a control slide 9 of a conventional metering and distributing valve 10.

The fuel is supplied via a fuel pump 13, which is driven by an electromotor, and which draws the fuel from a fuel tank 15 and conveys it via a line 16 to the metering and distributing valve 10. A return flow line 17 branches off from the line 16. A pressure limiting valve 18 is connected in this return flow line 17. The front side of the control slide 9 facing away from the pivot lever 6 is acted upon, via a line 19 branching off from the line 16, by the fuel under constant pressure which thus acts as a restoring force on the measuring member 2.

When the lever 6 effects a pivoting movement in the flow direction of the combustion air, the measuring member 2 in the funnel-shaped manifold section 3 connected to induction tube 4 is displaced and thus the varying annular cross-sectional area between the measuring member 2 and the funnel-shaped manifold section 3 is proportional to the adjustment path of the measuring member 2. If this requirement is satisfied, there is a linear dependence between the adjusting movement of the measuring member 2 and the displacement movement of the control slide 9 so that a quantity of fuel proportional to the air flowing through the induction tube 4 is always metered out. The metered quantity of fuel passes from the metering and distributing valve 10, via ducts 20, to the individual injection valves (not shown) disposed in the proximity of the cylinders (not shown) of the internal combustion engine.

The end of the pivot lever 6 facing away from the pivot point 7 is provided with a stop 22 on its side facing away from the measuring member 2. A spring 23 having linear characteristic rests against the stop 22.

As represented in FIG. 2, the spring 23 may be in the form of a flat spring which holds the measuring member 2 in its quiescent position when the fuel injection system is not in operation. The quiescent position of the spring 23 is determined by a hook 24 on one end of which the spring 23 can rest and the other end of which is connected to a yoke 25. The yoke 25 is a steel yoke rigidly connected to the conical manifold section 3 by screws 26. The yoke 25 is provided, in its central region, with a resilient, elastic stop 27 which may be made, for example, of rubber and which is arranged in such a way that the stop 22 of the pivot lever 6 comes to rest against the elastic stop 27 when the measuring member 2 passes through its quiescent position backwardly beyond the narrowest portion of the conical manifold section 2.

The illustrated embodiment of the fuel injection system according to the present invention has the advantage that when backfiring shocks occur in the induction tube 4, the measuring member 2 can pass through its quiescent position in the conical manifold section 3 thereby enabling the annular gap between the measuring member 2 and the inner wall of the conical manifold section 13 to be further increased thus relieving the pressure. The spring 23 must possess a sufficiently linear characteristic to enable rapid passage of the measuring member 2 through its quiescent position and to allow for rapid pressure reduction in the induction tube 4. On passage through the quiescent point the forces of inertia acting on the movement of the measuring member 2 must be absorbed by the elastic stop 27 after a sufficiently large annular gap has enabled pressure to be relieved. The elastic stop 27 should be constructed in such a way that it converts a maximum amount of energy into heat to avoid an excessive recoil of the measuring member 2. To enable the yoke 25, which is provided for the elastic stop 27, and which is in the form of a steel yoke to be as small as possible, in spite of the relatively large forces which may exist, it is constructed in such a way that a maximum pulling component and low bending forces are produced. The measuring member 2 is returned to its quiescent position by the spring 23 which comes to rest against the hook 24 in the course thereof.

It is to be appreciated that the foregoing description and accompanying drawing relate to an exemplary embodiment given by way of example not by way of limitation. Numerous other embodiments and varients are possible within the spirit and scope of the present invention, the scope being defined in the appended claims.

What is claimed is:

1. In a fuel injection system for externally ignited, internal combustion engines having means for continuously injecting combustion air into an induction tube means including a funnel-shaped section and in which a measuring member and a randomly activatable throttle valve are arranged in series, said measuring element being displaceable against a restoring force by a working member in accordance with the amount of air flowing through, and an adjustable mobile part of a valve disposed in a fuel line for metering out a quantity of fuel proportional to the quantity of air, the restoring force being provided by pressure fluid which is passed in a continuous manner under constant but randomly variable pressure through a pressure line and which acts on said working member, said measuring member being a plate which is secured, in its quiescent position, at a right angle to the flow direction on one end of a

pivoted lever mounted in a substantially friction-free manner, said measuring member projecting proportionally to the amount of air flowing through said induction tube means into a corresponding portion of said funnel-shaped section of said induction tube means extending in the flow direction, the improvement comprising a spring having a substantially linear characteristic positioned in the vicinity of said measuring member for providing a force against which said measuring member must act as it passes backwardly past its quiescent position during backfiring in said induction tube means, and an elastic stop means behind said measuring member for arresting backward motion thereof.

2. A fuel injection system as defined in claim **1**, including a steel yoke rigidly secured to said induction

tube means, said elastic stop means being disposed on said yoke.

3. A fuel injection system as defined in claim **1**, wherein said spring having a substantially linear characteristic keeps said measuring member in its quiescent position when the fuel injection system is out of operation.

4. A fuel injection system as defined in claim **3**, wherein said spring having a linear characteristic is a flat spring.

5. A fuel injection system as claimed in claim **1**, including an air filter housing, and wherein said conical portion of said induction tube means and said measuring member are disposed within said air filter housing.

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