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[54] **FUEL INJECTION APPARATUS FOR GAS TURBINE-TYPE VEHICLE POWER PLANT**

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[73] Assignee: **Robert Bosch GmbH,** Stuttgart, Germany

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[51] **Int. Cl.** **F04b 49/08**

[58] **Field of Search** .... 417/279, 395; 123/119 R; 239/126, 76, 533

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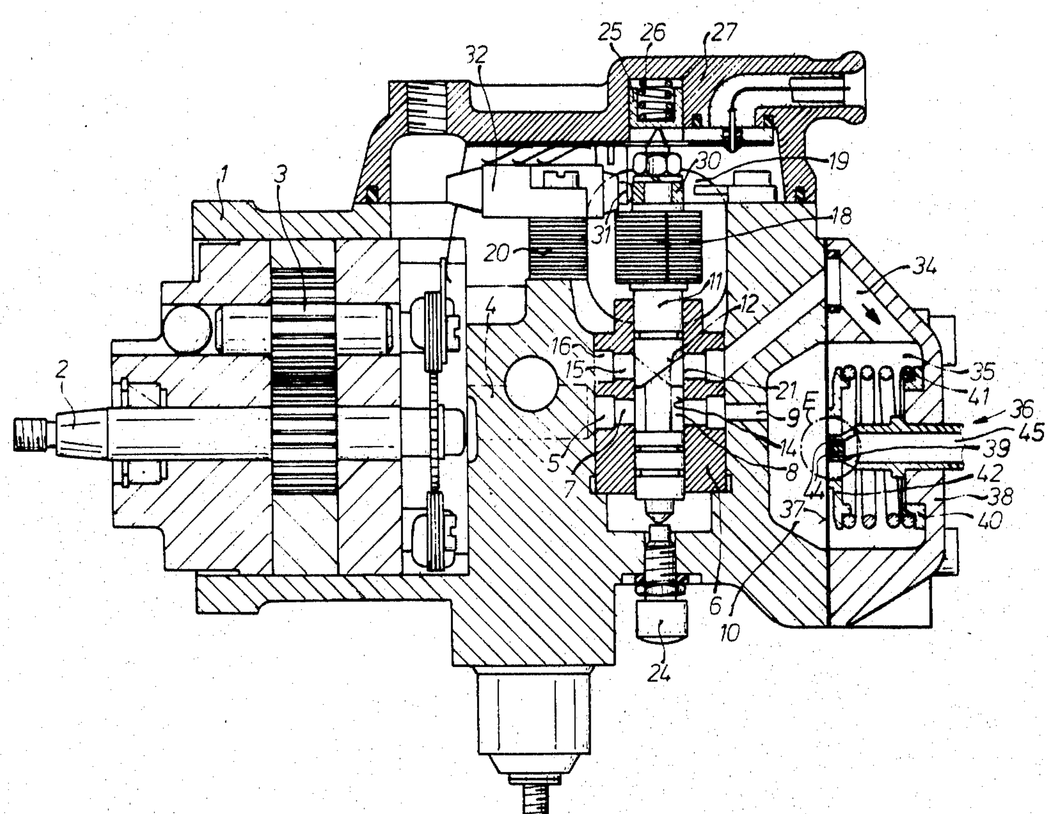
[57] **ABSTRACT**

In a fuel injection apparatus of the type that is associated with a gas turbine-type vehicle power plant, there is provided a differential pressure valve which is disposed in the fuel path and which ensures a constant pressure drop across a fuel metering valve regardless of the fuel quantities metered thereby. In order to reduce the back pressure effect of the fuel on the operation of the differential pressure valve, the stationary flat valve seat of the latter has, instead of one, a plurality of fuel flow openings, so that the pressure cross section for any given opening cross section is reduced with respect to known differential pressure valves.

4 Claims, 6 Drawing Figures



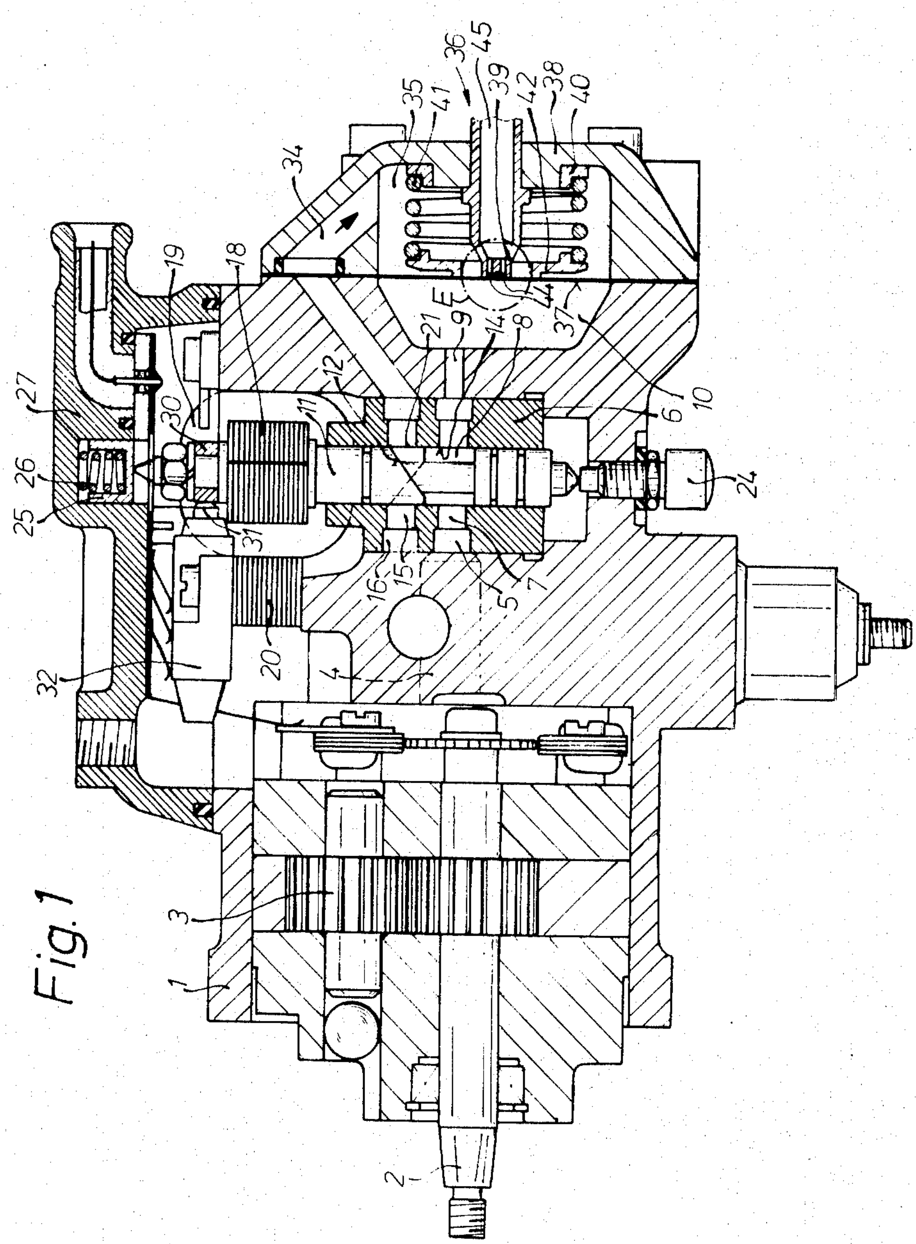

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Fig. 1

Fig. 2

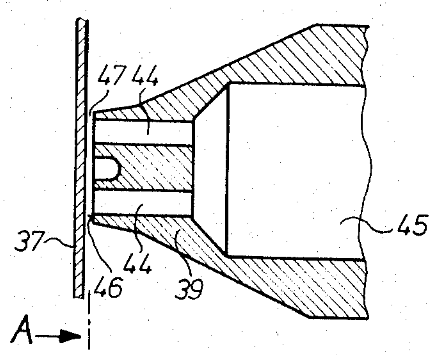


Fig. 3a

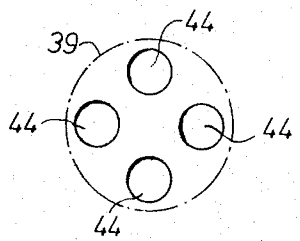


Fig. 3b

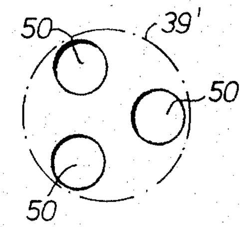


Fig. 3c

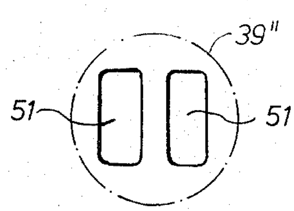
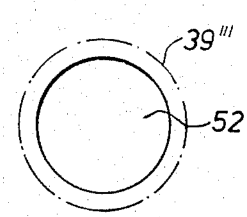


Fig. 3d

PRIOR ART



FUEL INJECTION APPARATUS FOR GAS TURBINE-TYPE VEHICLE POWER PLANT

BACKGROUND OF THE INVENTION

This invention relates to a continuously operating fuel injection apparatus for gas turbines which are used in particular in motor vehicles. The fuel injection apparatus is of the type that has a continuously operating fuel injection pump and a device for the regulation of the injected fuel quantities. The device varies the position of a control plunger which meters the fuel quantities admitted to the fuel injection nozzles. At the metering valve containing the control plunger there is ensured a constant pressure drop by providing a differential pressure valve in the fuel path. Furthermore, the fuel injection apparatus is of the type that is provided with means for the rpm-dependent control of the fuel quantities, means for limiting the pressure within the hydraulic system and means for protecting the fuel injection apparatus against runaway rpm's and excessive temperatures. The fuel injection apparatus is also provided with an electromagnetic system which varies the flow passage section of the aforenoted fuel metering valve and which is directly connected with the control plunger and is disposed within the housing of the fuel injection apparatus.

In a fuel injection apparatus of the aforenoted type, the differential pressure regulated by the differential pressure valve may fluctuate in response to the different values of the fuel back pressure in the injection or pressure conduit leading to the injection nozzles. Consequently, the metered fuel quantities do no longer correspond exactly to the fuel quantities assigned to the prevailing operational conditions of the power plant.

OBJECT AND SUMMARY OF THE INVENTION

It is an object of the invention to provide an improved fuel injection apparatus of the aforeoutlined type wherein the effect of the fuel back pressure on the differential pressure valve is decreased.

Briefly stated, according to the invention, for the purpose of reducing the effect of the fuel back pressure in the pressure conduit on the differential pressure valve, the stationary valve seat of the differential pressure valve is so designed that its pressure cross section for any given opening cross section is smaller than in a conventional valve having a sole fuel flow opening. The opening cross section is formed by the perimeter of the flow openings and the opening gap between the valve membrane and the frontal face of the stationary valve seat.

The invention will be better understood, as well as further objects and advantages become more apparent, from the ensuing detailed specification of three exemplary embodiments taken in conjunction with the drawing.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a longitudinal sectional view of the fuel injection apparatus incorporating the first embodiment of the invention;

FIG. 2 is a sectional view on an enlarged scale of the component encircled at E in FIG. 1;

FIG. 3*a* is a view of the structure shown in FIG. 2 in the direction of arrow A;

FIG. 3*b* is a second embodiment of the invention taken in the same direction as FIG. 3*a*;

FIG. 3*c* is a view of a third embodiment of the invention taken in the same direction as FIG. 3*a*; and

FIG. 3*d* is a view of a conventional valve configuration taken in the same direction as FIG. 3*a*.

DESCRIPTION OF THE EMBODIMENTS

Turning now to FIG. **1**, there is shown a regulator housing **1** containing a gear pump **3** which serves as a fuel injection pump and which is driven by a drive shaft **2**. The pump **3** delivers fuel through a bore **4** into an annular groove **5** of a sleeve **6**. From the groove **5** the fuel flows through radial bores **7** into an annular chamber **8** which is bounded by a control plunger **11** and the internal wall of the sleeve bore **14**. The two control edges **12** of the control plunger **11** and the corresponding control slots **15** provided in the sleeve **6**, form a metering valve. The position of the control edges **12** with respect to their associated control slots **15** defines a flow passage section **21** which is directly variable by means of a quantity setting device directly connected with the control plunger **11**. This device includes a rotary magnet **18** which is supported rotatably between two solenoids **19** which, in turn, are positioned on a core **20**. In this manner a closed magnetic circuit may be established through the rotary magnet **18** and the core **20**. The rotary magnet **18** is secured to the control plunger **11** which is prevented from moving axially by a set screw **24** urging the control plunger **11** into engagement with an abutment **25** which, in turn, is biased by a spring **26** held in a lid **27**.

On the control plunger **11** there is also mounted a cam disc **30** which, as a function of the angular position of the control plunger **11**, actuates a follower **31** of a position sensor **32** which may be an inductive transducer.

The fuel metered at the control slots **15** flows through an annular groove **16** provided in the sleeve **6** and a channel **34** into a chamber **35** of a differential pressure valve generally indicated at **36**. The latter is formed as a flat seat valve and is provided with a membrane **37** clamped coplanar with a stationary valve seat **39** between the regulator housing **1** and a valve housing **38**. The valve housing **38** supports, through an intermediate ring **40**, a coil spring **41** which has a flat spring characteristic. The spring **41** biases the membrane **37** through a spring seat disc **42** in the opening direction; consequently, the differential pressure valve **36** is in an open position when inoperative. From the annular groove **5** the fuel flows in an unthrottled manner through the bore **9** into a chamber **10** of the differential pressure valve **36**.

When the differential pressure valve **36** is in an open position, fuel may flow from the chamber **35** between the membrane **37** and the stationary valve seat **39** through its bores **44** into the pressure conduit **45** leading to a fuel injection nozzle (not shown).

In operation, fuel is delivered by the gear pump **3** to the metering valve **12, 15** where a metering is effected under conditions of constant pressure drop ensured by the differential pressure valve **36**. In this manner, the flow passage section **21** is a measure for the throughgoing fuel quantities.

In FIG. **2** there is shown, to an enlarged scale, details of the components encircled at E in FIG. **1** and FIG. **3***a* illustrates the stationary valve seat **39** as seen in the direction of the arrow A of FIG. **2**. As it may be observed from FIGS. **1, 2** and **3***a*, the stationary valve seat **39** is provided with flow openings **44**, the perimeter of which, together with the opening clearance **47** between the frontal face **46** of the stationary valve seat **39** and the membrane **37**, constitutes the opening cross section of the valve **36**. The individual cross sections of the four bores **44** form together the pressure cross section through which the fuel back pressure prevailing in the injection conduit **45** exerts a force on the membrane **37** of the differential pressure valve **36**.

In FIG. **3***b* there is shown a further embodiment of the invention formed of a stationary valve seat **39**′ having three bores **50** of identical cross section.

In FIG. **3***c* there is shown a third embodiment wherein the stationary valve seat **39**″ is provided two rectangular openings **51** of identical cross section.

FIG. **3***d* illustrates a conventional valve configuration wherein the valve is formed by a stationary valve seat **39**‴ having a single axial central bore **52**.

In case of an identical opening clearance **47** between the membrane **37** and the frontal face **46** of the stationary valve seat, the embodiments illustrated in FIGS. **3***a*, **3***b*, **3***c* and **3***d* have the same opening cross section. The embodiments shown in FIGS. **3***a*, **3***b* and **3***c* have, however, a substantially smaller pressure cross section than that of the conventional valve configuration shown in FIG. **3***d* and formed by the sole bore **52**. The pressure cross section in the three embodiments is the sum of individual cross sections of the openings **44**, **50** or **51**. By virtue of the smaller pressure cross section present in the three embodiments, the disturbing effect of the fuel back pressure on the constant pressure difference is reduced to a minimum value.

We claim:

1. In a continuously operating fuel injection apparatus that is associated with a turbine-type vehicle power plant and is of the known type that has (a) a fuel metering valve including a displaceable control plunger which, dependent upon its position, meters fuel quantities delivered through pressure conduit means to fuel injection nozzles, (b) a device operatively connected to said control plunger for varying the position thereof

and (c) a differential pressure valve positioned in the path of the fuel and communicating with said fuel metering valve to ensure a constant pressure drop therethrough independently of the metered fuel quantities, the improvement in said differential pressure valve having a given opening cross section, comprising

A. a first chamber in communication with said fuel path immediately upstream of the location of metering in said fuel metering valve,

B. a second chamber in communication with said fuel path immediately downstream of the location of metering in said fuel metering valve,

C. a membrane separating said chambers from one another and moving in response to the pressure difference in said chambers and

D. a stationary flat valve seat disposed in said pressure conduit means and cooperating with said membrane to regulate the flow of fuel from said second chamber to said pressure conduit means as a function of the pressure difference in said chambers, said flat valve seat having a plurality of throughgoing flow openings to establish communication between said second chamber and said pressure conduit means in an open position of said differential pressure valve, said flow opening being dimensioned to retain said given opening cross section and decrease the pressure cross section of said valve seat for reducing the effect of the back pressure of fuel in said pressure conduit means on said membrane.

2. An improvement as defined in claim **1**, wherein said flow openings are three in number and have circular configurations of identical cross section.

3. An improvement as defined in claim **1**, wherein said flow openings are four in number and have circular configurations of identical cross section.

4. An improvement as defined in claim **1**, wherein said flow openings are two in number and have rectangular configurations of identical cross section.

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