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Harings, deceased

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[54] **FUEL PROPORTIONING SYSTEM FOR A COMBUSTION ENGINE**

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[51] **Int. Cl.** **F02m 51/00**

[58] **Field of Search** 123/139, 119, 32

[56] **References Cited**

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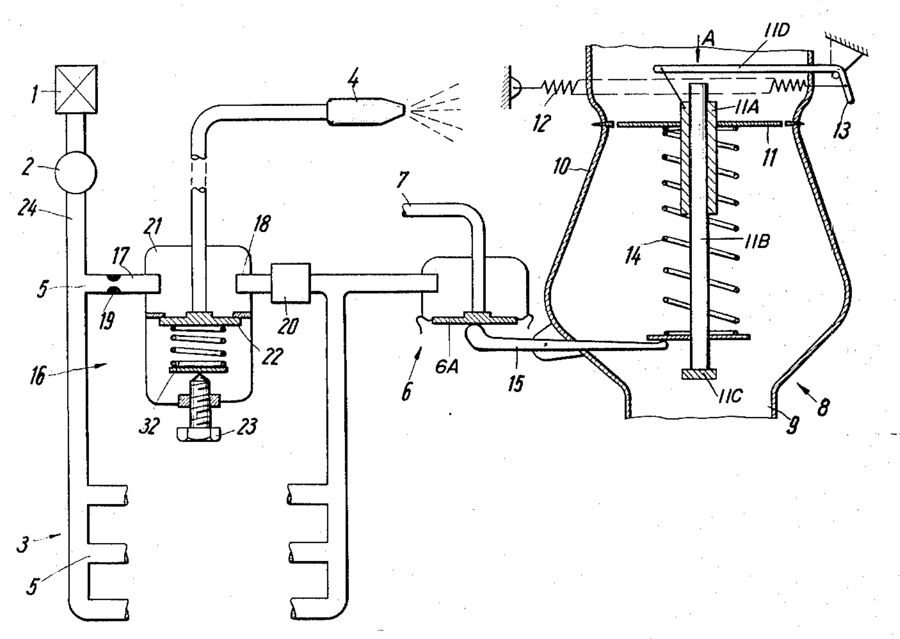
[57] **ABSTRACT**

A fuel proportioning system is provided for an internal combustion engine. Fuel is supplied under constant pressure through a throttle to a proportioning valve having one outlet through an injection nozzle and a return outlet through a diaphragm actuted needle valve to a throttle valve controlled in accordance with the volume of air admitted to the engine to return supply fuel to the pump. The proportioning valve is spring urged to closed position and is opened by fuel pressure in the proportioning valve. The valve closure member flutters between open and closed position to pulse the fuel delivered to the injector nozzle, the pulsed fuel flow being more readily controllable in small volumes than a continuous fuel flow.

4 Claims, 2 Drawing Figures



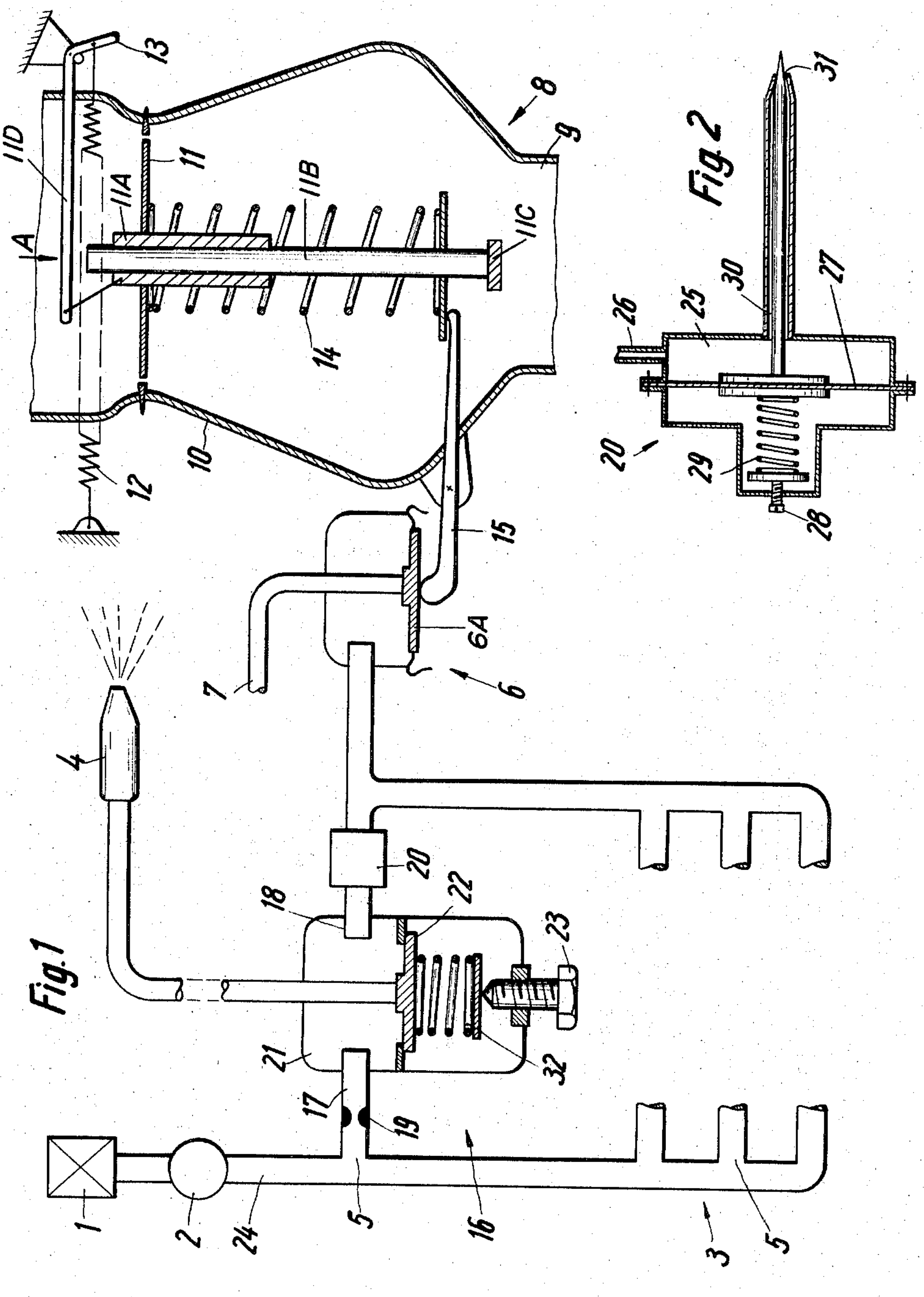


Fig.1
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FUEL PROPORTIONING SYSTEM FOR A COMBUSTION ENGINE

This invention relates to a fuel proportioning system for a combustion engine.

Such a system has been known for some time, as from U.S. Pat. Nos. 2,318,216 and 2,591,356, in order to maintain the required proportionality between the fuel supply and the combustion air throughput, so that the optimum fuel/air mixture is formed. Means mounted in the intake manifold continuously measures the air throughput and adjusts a fuel proportioning valve in accordance with the measurements. Usually, the required adjustment is effected by direct control of the fuel proportioning valve, which is subjected to a constant pressure of fuel.

It has also been proposed, as in German Pat. specification No. 1,960,144, to effect control by means of an adjustable throttle valve in the return flow of the fuel back to the supply; the proportioning valve is then connected to the supply upstream of the adjustable throttle valve and has a delivery outlet connected to injection apparatus in the intake manifold of the engine. In these proposals, however, the proportionality between the combustion air throughput and the rate of fuel supplied is continuously altered in accordance with certain engine operating magnitudes, by a method in which the fuel conveyed by the fuel pump is caused to move in a main flow past the proportioning valve, on which the air throughput measuring means acts direct, the pressure of the fuel being adjusted in the return flow by throttle valves which are adjusted by the engine operating values; the adjustment of flow serves to exert, on the proportioning valve, a force acting oppositely to that exerted by the air flow measuring means, and of which the magnitude corresponds to the particular pressure prevailing in the main fuel flow at the time.

All the known systems suffer from a difficulty arising from the wide regulating range of a combustion engine between idling and full load. In all cases, the proportioning valves are continuously open, even in the partial-load range. Since, however, the proportioning valves and their regulating devices have to be designed for maximum fuel throughput at full load, the quantity of fuel to be passed under no-load conditions is of the same order of magnitude as the limits of error dictated by tolerances and other factors of the regulating system. This results in incorrect fuel metering, particularly in the no-load and lower part-load ranges.

The invention is directed towards providing a fuel proportioning system in which the fuel is accurately proportioned, not only at full-load and in the upper part-load range, but also under no-load conditions and in the lower part-load range.

This is achieved, in the present invention, by having the means responsive to the throughput of combustion air adjust the throttle valve in the return fuel flow, and having the proportioning valve consist of a spring-loaded pressure-responsive valve controlling the fuel to the delivery output, means in the connection of the fuel supply to the proportioning valve preventing instantaneous pressure equalisation in the valve on opening of the valve to deliver fuel to the engine.

Thus, the invention provides a fuel proportioning system for a combustion engine comprising a supply of fuel at constant pressure; a proportioning valve connected to the fuel supply having a delivery outlet for connection to injection apparatus in an inlet manifold of the engine, and a return outlet; an adjustable throttle valve connected between the return outlet and a return conduit to the supply, and controlling the rate of fuel returned to the supply; and means responsive to the throughput of combustion air for controlling the throttle valve and hence the fuel pressure in the proportioning valve; the proportioning valve comprising a spring-loaded pressure-responsive valve controlling the flow of fuel to the delivery outlet and means in the connection to the fuel supply to prevent instantaneous pressure equalisation in the valve on opening of the delivery outlet.

The system operates to supply fuel intermittently to the delivery outlet, the pressure-responsive valve opening and closing in a pulsating manner and allowing a small quantity of fuel to pass during each opening cycle. In that way, the problem is overcome of measuring very small quantities of fuel in a system designed for a large, maximum, fuel throughput.

The duration and frequency of the opening of the valve are determined by the pressure downstream of the valve, which in turn depends on the adjustment of the adjustable throttle valve controlled by the air throughput. Overall adjustment is made possible by making the spring loading of the pressure responsive valve adjustable.

The invention will be more readily understood by way of example from the following description of a fuel proportioning system for a combustion engine, reference being made to the accompanying drawings, in which

FIG. **1** is a schematic diagram of the system, and

FIG. **2** shows in section a diaphragm controlled needle valve provided in the system.

Referring to FIG. **1,** a fuel pump **1** supplies fuel under pressure to a conduit **24** which contains a pressure governor **2** by which the pressure of the delivered fuel is kept constant in a distributor pipe **3.** From the distributor pipe **3,** a branch **5** leads to an inlet chamber **21** of a spring-loaded pressure-responsive valve **16** and from thence to the pressure chamber of a throttle valve **6.** The throttle valve **6** has an outlet conduit **7** which returns fuel to the fuel reservoir (not Shown) to which pump **1** is connected. Open end of conduit **7** is shown as closed by a diaphragm **6A,** but which can be opened as described below to permit passage of fuel through the conduit **7.**

Throttle valve **6** is controlled in part by means responsive to the throughput of combustion air, indicated generally at **8.** These means take the form of an air intake manifold **9** having the usual butterfly valve (not shown) and containing a disc **11.** Disc **11** is mounted on a sleeve **11A,** slidably arranged on a shaft **11B** which is secured in place by a transverse mounting **11C** secured in the manifold **9.** The sleeve **11A** is attached to a crank arm **11D,** which is acted on by a spring **12,** so that the sleeve **11A** and hence the disc **11** is biased upwardly to close against a restricted part **10** of the manifold **9.** A spring **14** surrounding the shaft **11B** acts at its ends against disc **11** and one end of a lever **15,** which is pivoted intermediate its ends on the casing manifold **9.** The other end of lever **15** acts on the diaphragm **6A** of the throttle valve **6.**

When the engine is inoperative, the disc **11** closes the manifold. However, during operation of the engine, the engine suction, acting in the direction of the arrow A, opens disc **11** and, through the spring **14** and lever **15**, loads the diaphragm 6A upwardly. The greater the throughput of air through the manifold, the greater the displacement of the disc **11**, the stressing of the spring **14** and the force exerted by lever **15** on the diaphragm **6**A.

The force exerted by lever **15** acts in opposition to the pressure of fuel within the throttle valve **6**. When the throughput of air is small, the fuel pressure causes the diaphragm 6A to move downwardly and to open the conduit **7** for return of fuel to the reservoir, so that little fuel is directed to the engine. However, when the air flow increases, the fuel pressure is progressively overcome, the throttle valve **6** closing and causing a greater supply of fuel to the engine.

Turning now to the valve **16**, the inlet chamber **21** is closed on one side by a valve disc **22** which is biased upwardly against its seat by a spring **32**, which can be adjusted by a screw **23**. In the uppermost position of the valve disc **22**, i.e., as shown in FIG. **1**, the valve disc closes off a delivery outlet leading to an injection nozzle **4**, by which fuel is injected into the intake manifold of the engine.

A throttle, in the form of a restriction **19**, is provided upstream of valve **16** to prevent rapid instantaneous equalisation of pressure between the distributor pipe **3** and the inlet chamber **21** of the valve **16**, when valve disc **22** opens to allow fuel to pass to the nozzle **4**.

Similarly, a further throttle **20** is provided downstream of the valve **16**, this throttle consisting of a diaphragm-controlled regulating valve which is shown in detail in FIG. **2**. In that figure, the inlet connection **26** of the needle valve is connected to the return outlet **18** of the valve **16**. The needle valve **20** has an elongated discharage outlet which is connected to the throttle valve **6** and which contains a needle **30** carried on a diaphragm **27** within the valve chamber **25**. In the chamber **25**, the fuel pressure acts on the diaphragm **27** and holds the valve in the open position, needle **30** being retracted in opposition to the force of a spring **29** acting on the diaphragm **27** and adjusted by means of an adjusting screw **28**. If the pressure in the inlet chamber **21** of valve **16** collapses instantaneously on opening of that valve, the resulting pressure drop in chamber **25** of valve **20** permits spring **29** to cause needle **30** to close the discharge passage **31**; the result is that throttle valve **6** is not affected by the pressure drop.

The system operates as follows:

While the engine is operating, the passage of combustion air through the manifold **9** causes a force to be applied, as described above, against the diaphragm 6A in opposition to the fuel pressure acting on that diaphragm. Throttle valve **6** is thus opened to an extent dependent on the flow of combustion air to the engine. This in turn determines the fuel pressure within the chamber of valve **6**. Throttle **19** permits the existence of a fuel pressure in throttle valve **6**, and therefore in inlet chamber **21** of a value less than that delivered by the fuel pump **1** and governor **2**.

While the engine is in operation, valve **32** operates intermittently to supply fuel to jet **4** in a pulsating manner. The fuel pressure in chamber **21**, controlled by throttle valve **6** as described, causes valve disc **22** to move away from its seat against the action of spring **32** and to allow fuel to pass to nozzle **4**. When valve disc **22** opens, the pressure within chamber **21** drops as a consequence. At the same time, the pressures on the two sides of valve disc **22** are equalised, so that spring **32** causes the valve to reclose. The delivery opening of valve **16** having therefore been closed, the pressure in chamber **21** rises again to cause a further short-term opening of valve disc **22**. The duration of each opening of valve **16** and the repetition rate of opening are determined by the pressure within throttle valve **6**, which in turn is determined by the rate of flow of combustion air through mainfold **9**. Thus, the rate of supply of fuel to nozzle **4** is kept strictly proportional to the supply of air and the required fuel/air mixture is maintained. Needle valve **20** operates as described above to ensure that throttle valve **6** is unaffected by the short term variations in the pressure in inlet chamber **21** as the valve **16** operates intermittently.

The above description has been concerned with a system in which there is a single branch **5** from the distributor pipe **3**, the fuel being supplied by the valve **16** to a single nozzle **4** feeding fuel to the main intake mainfold. However, there may be additional branches **5**, as shown in the lower part of FIG. **1**, the total number of branches corresponding to the number of intake manifolds provided on the vehicle. In that case, each branch **5** is connected to a separate pressure responsive valve **16**, the return outlets of all the valves being connected to the single throttle valve **6**. Each valve **16** has a separate discharge outlet leading to a nozzle for one of the intake manifolds.

We claim:

1. A fuel proportioning system for a combustion engine comprising a supply of fuel at constant pressure; a proportioning and pulsing valve connected to the fuel supply and having a delivery outlet for connection to injection apparatus in an inlet manifold of the engine, and a return outlet; an adjustable throttle valve connected between the return outlet and a return conduit to the supply, and controlling the rate of fuel returned to the supply; and means responsive to the throughput of combustion air for controlling the throttle valve and hence the fuel pressure in the proportioning valve; the proportioning and pulsing valve comprising a spring-loaded pressure responsive valve controlling the flow of fuel to the delivery outlet being spring urged toward closed position and being urged open by fuel pressure, said valve oscillating open and closed to pulse the fuel to the delivery outlet and means in the connection to the fuel supply to prevent instantaneous pressure equalisation in the valve on opening of the delivery outlet.

2. A fuel proportioning system according to claim **1**, in which the proportioning valve has an inlet chamber connected both to the return outlet and the fuel supply, and throttles are provided both in the return outlet and in the connection to the fuel supply.

3. A fuel proportioning system for a combustion engine comprising a supply of fuel at constant pressure; a proportioning valve connected to the fuel supply and having a delivery outlet for connection to injection apparatus in an inlet manifold of the engine, and a return outlet; an adustable throttle valve connected between the return outlet and a return conduit to the supply, and controlling the rate of fuel returned to the supply; and means responsive to the throughput of combustion air for controlling the throttle valve and hence the fuel pressure in the proportioning valve; the proportioning valve comprising a spring-loaded pressure responsive valve controlling the flow of fuel to the delivery outlet and means in the connection to the fuel supply to prevent instantaneous pressure equalisation in the valve on opening of the delivery outlet, the proportioning valve having an inlet chamber connected both to the return outlet and the fuel supply, throttles being provided both in the return outlet and in the connection to the fuel supply, the throttle in the return outlet comprising a diaphragm regulated needle valve arranged to close under spring action when the pressure on the diaphragm decreases relative to that of the adjustable throttle valve.

4. A fuel proportioning system according to claim **3,** in which the spring-loaded pressure-responsive valve includes adjustable spring loading means.

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