Jan. 2, 1951 L. S. GREENLAND 2,536,440

FUEL DISTRIBUTING VALVE

Filed April 16, 1946 2 Sheets-Sheet 1

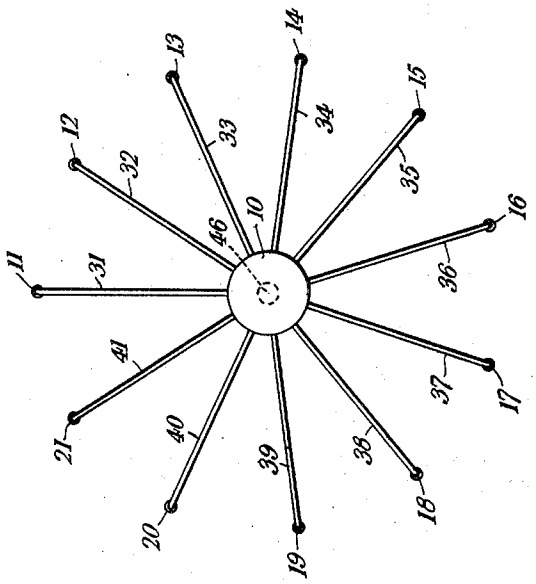


Fig. 1.

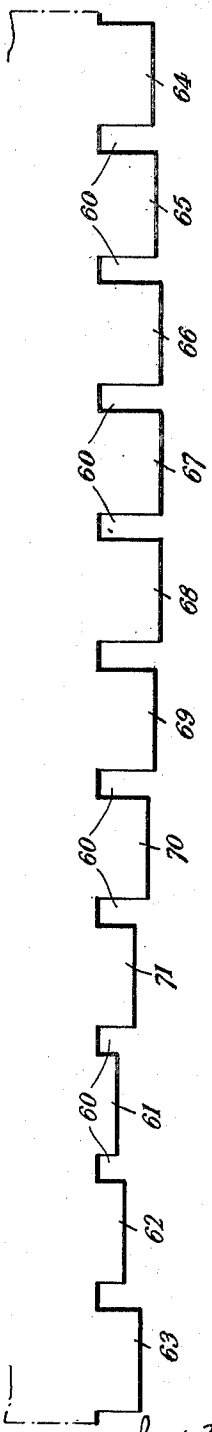


Fig. 3.

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FUEL DISTRIBUTING VALVE

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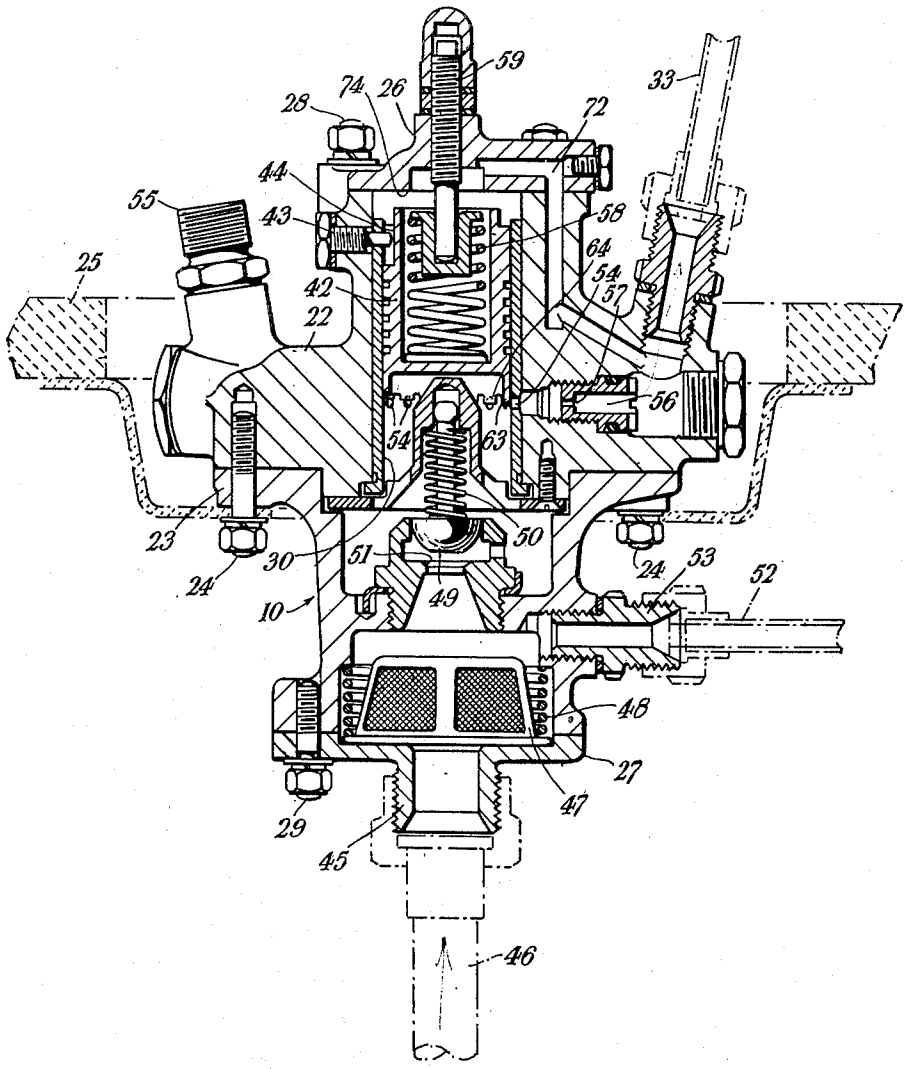


Fig. 2.

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Patented Jan. 2, 1951

2,536,440

UNITED STATES PATENT OFFICE

2,536,440

FUEL DISTRIBUTING VALVE

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Application April 16, 1946, Serial No. 662,487
In Great Britain May 22, 1945

4 Claims. (Cl. 137—153)

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This invention relates to fuel injection systems for internal combustion engines of the type in which fuel is injected into the engine from a distributor through pipes leading each to one of a plurality of nozzles situated around the periphery of the engine at different levels. Such arrangements are used with combustion turbine engines, and the nozzles are often arranged in a circle of considerable diameter so that there are substantial differences in the hydraulic head in the several distributing pipes. The effects of these differences are not material when the engine is running under conditions such that there is a high pressure in the inlet line by which fuel is fed to the distributor. When, however, the fuel pressure in the inlet line falls to low values, the differences in hydraulic head may lead to serious unevenness of distribution of fuel to the nozzles.

The invention provides a fuel distributor for use in an injection system of the above character, comprising a cylinder having an inlet for connection to the fuel inlet line, a piston valve located in the cylinder, a plurality of radial holes in the cylinder each communicating, via a restricted passage, with an outlet for connection to a delivery pipe leading to one of the nozzles, and a spring operating on the valve in opposition to the fuel pressure at the inlet, which spring is normally overpowered by the fuel pressure so that the holes are unobstructed by the valve, but is effective to cause partial obstruction of the holes when the fuel pressure at the inlet falls below a given value, the disposition of the holes and/or the shape of the valve head being such that, under these conditions, the effective areas of the holes are such as to counteract the differences in hydraulic head in the associated delivery pipes and tend to equalise the rate of flow of fuel through the nozzles.

To achieve this result, the effective area of a hole leading to a delivery pipe in which there is a large hydraulic head must be greater than that of a hole leading to a pipe in which there is a smaller hydraulic head; and a considerable degree of equalisation of the fuel flow through the nozzles can be achieved by suitable selection of the location of the holes and/or of the shape of the valve head.

The required equalisation can be effected by employing a level valve head, i. e. a valve head extending in a plane at right angles to the axis of the cylinder, and arranging the holes at different levels in the cylinder, so that they will be progressively obstructed by the valve head

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in the proper sequence as the valve is moved towards the holes by its spring.

It is however more convenient from a manufacturing standpoint to locate the holes at the same level in the cylinder and to arrange for differential masking thereof by the valve by appropriate shaping of the valve head. The valve head can be given an oblique continuous edge, so that as it moves into cooperation with the holes these will be blanked off to the extent necessary to counteract the effect of the varying hydraulic heads in the delivery pipes. This arrangement, however, necessitates very accurate location of the valve in the radial direction, and I prefer to form the valve head with stepped lands, i. e. lands of different height, each land cooperating with one of the holes. Preferably also the lands are separated by axially extending slots in the valve head, so as to permit of individual grinding of the lands.

The dimensions of the spring against the piston valve are such that the action of unmasking the holes in the cylinder is completed when the fuel inlet pressure is sufficient to reduce the unevenness of distribution to acceptable limits. Above this pressure, the valve is restrained from further movement and the flow of fuel to each nozzle is then determined by the calibrated restrictions.

One specific embodiment of the invention, as applied to a fuel distributor for use in a fuel supply system for a combustion turbine engine of the kind described in my copending application Serial No. 669,653, filed May 14, 1946, will now be described in further detail, by way of example, with reference to the accompanying drawings in which:

Fig. 1 is a diagram showing the fuel distributor and the pipes leading to the different nozzles,

Fig. 2 is a vertical section through the fuel distributor, and Fig. 3 is an enlarged development view of the valve head.

Considering first of all Fig. 1, the distributor 10 has to distribute fuel from an inlet pipe 46, via eleven distributing pipes 31—41 to eleven injection nozzles 11—21 arranged in a circle in a vertical plane, the diameter of which circle may be of the order of three feet. Consequently, when the fuel pressure in the inlet pipe is low, there will be substantial differences in hydraulic head in the distributing pipes, the head in the pipes 40, 41, 31, 32 leading to the upper nozzles being much greater than that in those 35—38 leading to the lower nozzles. The distributor 10 serves to equalise these differences in hydraulic

head at low fuel inlet pressures as will now be described with reference to Figs. 2 and 3.

The distributor 10, which is mounted on a supporting panel 25, comprises upper and lower body portions 22, 23 secured together by bolts 24, and a top cover plate 26 and a bottom cover plate 27 respectively held in position by bolts 28, 29. Within the upper body portion 22 is a cylinder 30, in which is slidably mounted a piston valve 42. A set screw 43, engaging in slot 44 in the valve 42, prevents the latter from turning in the cylinder 30.

The lower end of the cylinder 30 communicates with an inlet 45, to which is connected the fuel inlet pipe 46. Above the inlet 45 is a filter 47, located in position by a spring 48. Access of fuel from the inlet 45 to the lower end of the cylinder 30 is controlled by a mushroom valve 49, having a spring 50 for pressing it against a seating 51. When the engine is stopped, the valve 49 is closed and cuts off the cylinder 30 from the inlet 45, fuel for starting the engine being delivered from the inlet 45 through a starting line 52 connected to an outlet 53 located below the valve 49. For starting purposes fuel is fed to line 46, in accordance with known practice, from a priming pump (not shown) and is thence fed to the engine through the starting line 52 which is, at other times, closed by the usual priming cock (not shown).

When, however, the engine is running, valve 49 is held open by the fuel pressure at the inlet, and the fuel is able to flow into the cylinder 30. In the cylinder are provided eleven radial holes 54 located at the same level, i. e. in a common plane normal to the axis of the cylinder. Each hole communicates with an outlet 55 through a radial passage 56 containing a calibrated restriction 57. To these outlets are connected the distributing pipes which lead to the nozzles, one of these pipes being shown at 33 in Fig. 2.

The valve 42 is balanced against the fuel inlet pressure by a spring 58, the compression of which can be adjusted by a screw 59. Under normal conditions the fuel pressure holds the valve 42 above the level of the holes 54, so that the valve offers no restriction to flow through the holes, the flow to the nozzles being determined solely by the restrictions 57. Under these conditions the differences in hydraulic head in the distributing pipes are unimportant.

When, however, the fuel inlet pressure falls below a given value, the valve 42 moves down into the position shown in Fig. 2, in which its head partially obstructs the holes 54. The valve head, as shown in Fig. 3, is formed with eleven stepped lands 61—71, separated by axial slots 60. Each land cooperates with one of the holes 54, and the height of the lands is such that the differential masking of the holes 54, when the valve is operative, tends to equalise the differences in hydraulic head, the effective areas of the holes leading to the top nozzles being larger than the effective areas of the holes leading to the bottom nozzles.

A passage 72 serves to lead away to one of the outlets fuel which may leak past the valve 42, this passage only being open at the low pressures at which the valve 42 is operative, the amount of leakage then being very small and not disturbing the equalisation of pressure between the nozzles. At normal pressures, the upper end of the valve 42 is held by the fuel pressure in sealing engagement with a surface 74 and the passage 72 is closed. The amount of leakage past the valve 42 is determined by the pressure drop across the hole 54 and restriction 57. The restriction 57 is designed to take account of this leakage during calibration of the apparatus.

What I claim as my invention and desire to secure by Letters Patent is:

1. A fuel distributor, for use in distributing fuel to a plurality of locations at different levels in relation to the distributor, said distributor comprising a cylinder having an inlet for admitting fuel to the cylinder, a piston valve mounted to slide in and constrained against rotation in relation to the cylinder and having a head exposed to the fuel pressure at the inlet, a plurality of holes in the cylinder each communicating, via a restricted passage, with an outlet for feeding fuel to one of said locations, and a spring operating on the valve in opposition to the fuel pressure at the inlet, said spring being normally overpowered by the fuel pressure, so that all of the holes are unobstructed by the valve but being effective to move the valve to an operative position, in which its head partially obstructs the holes, when the fuel pressure at the inlet falls below a given value and the valve head and holes then cooperating to effect differential reduction of the effective areas of the holes for the purpose of counteracting differences of hydraulic head at the outlets.

2. A fuel distributor as claimed in claim 1, in which the holes are located at the same level in the cylinder and the valve head is shaped to provide differential masking of said holes when the valve is in operative position.

3. A fuel distributor as claimed in claim 1, in which the holes are located at the same level in the cylinder and the valve head is formed with stepped lands, each land cooperating with one of the holes, when the valve is in operative position, the lands effecting differential masking of the holes so as to counteract variations in hydraulic head at the outlets.

4. A fuel distributor as claimed in claim 1, in which the holes are located at the same level in the cylinder and the valve head is formed with stepped lands, said lands being separated by axially extending slots, each land cooperating with one of the holes when the valve is in operative position, the lands effecting differential masking of the holes so as to counteract variations in hydraulic head at the outlets.

LEONARD SIDNEY GREENLAND.

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