

July 15, 1958

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2,843,097

FUEL ENRICHMENT MEANS

Filed June 29, 1956

3 Sheets-Sheet 1

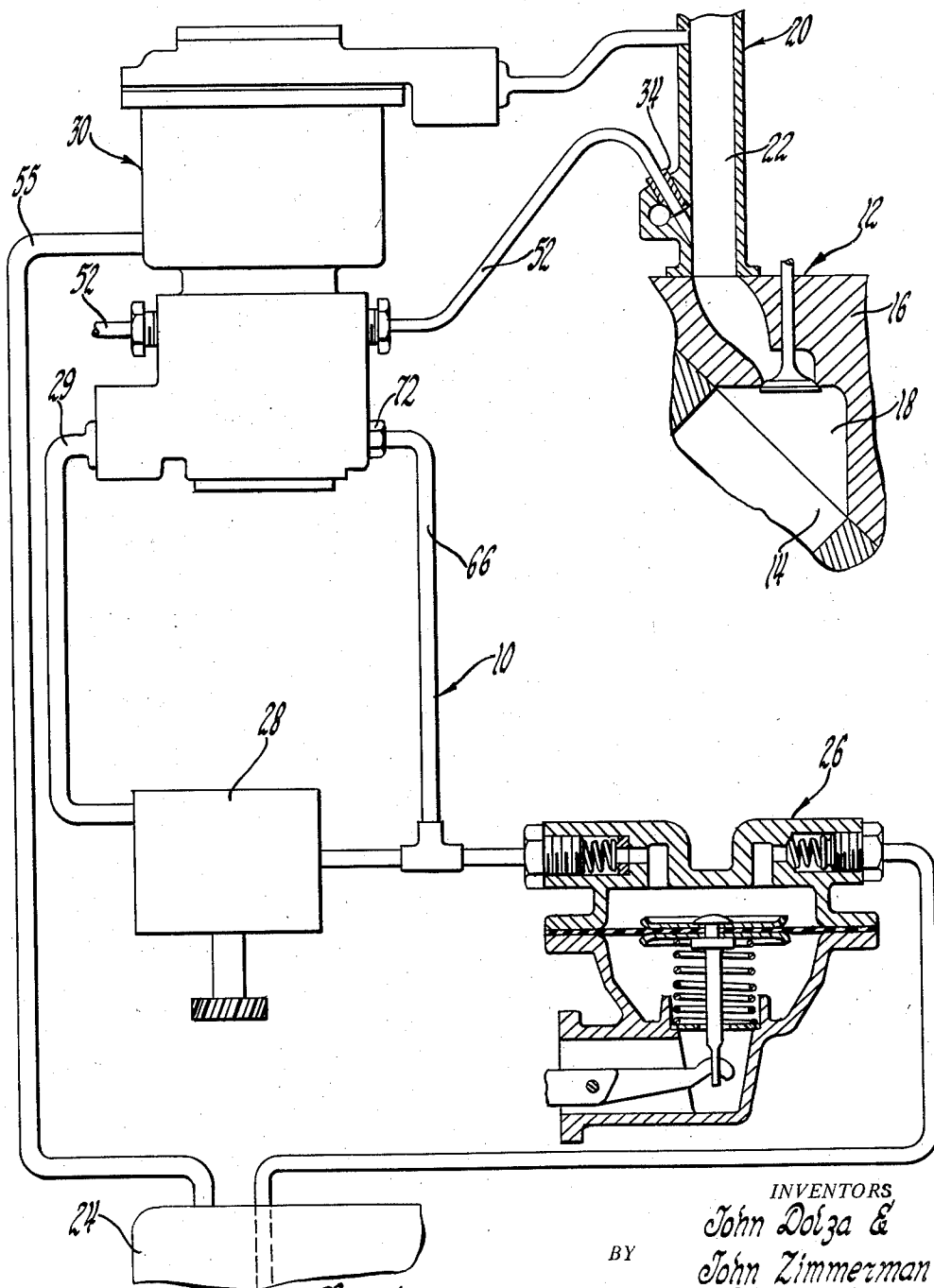


Fig. 2

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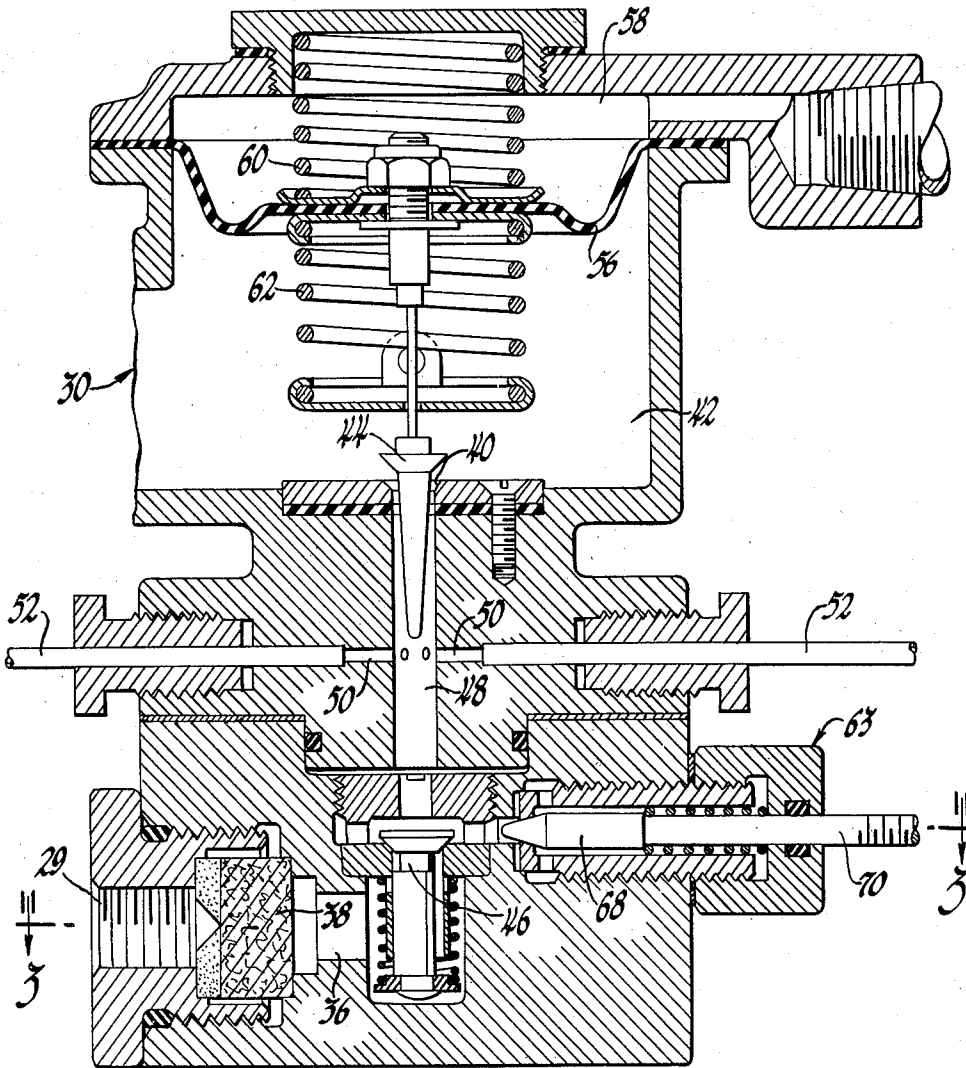


Fig. 2

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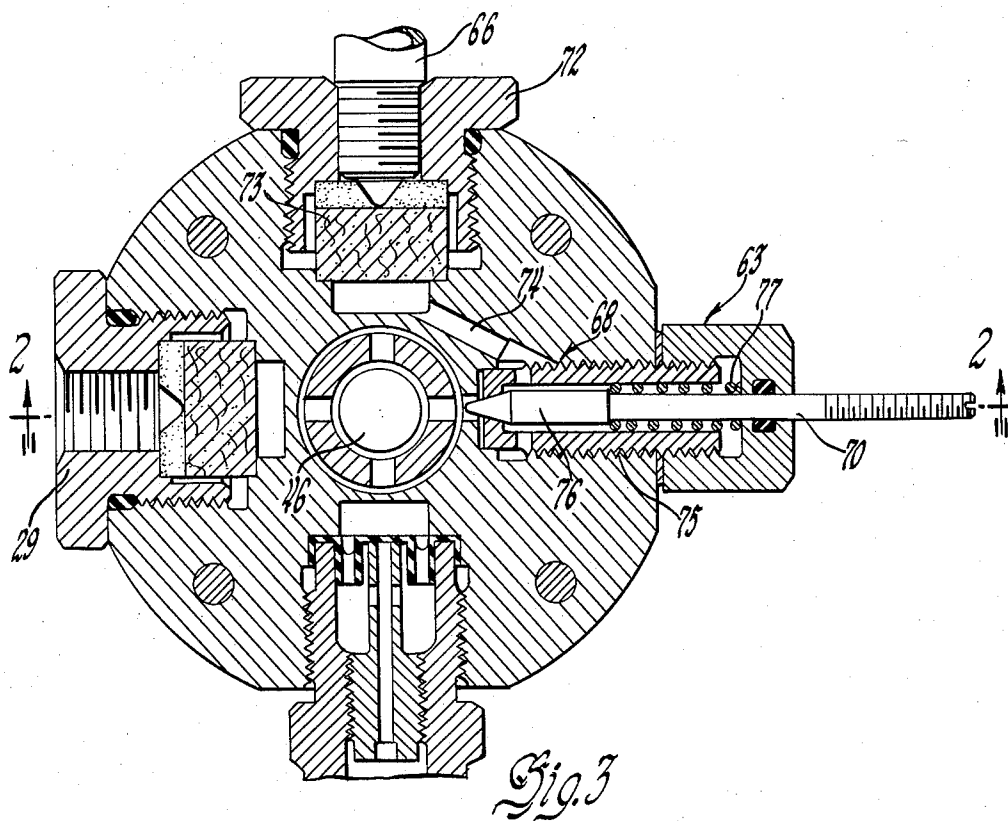
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FUEL ENRICHMENT MEANS

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Application June 29, 1956, Serial No. 594,797

8 Claims. (Cl. 123—119)

The present invention relates to fuel injection systems and more particularly to means for temporarily modifying the normal metering action of a fuel injection system to temporarily change the air-fuel ratio of the charge.

In the operation of an internal combustion engine a combustible charge of air and fuel may be formed by employing a fuel injection system which will inject metered quantities of fuel into the charge. Such an injection system normally employs a fuel pump and metering means responsive to the fuel demands of the engine for metering the fuel in proportion thereto. The metering means will normally provide a substantially constant air-fuel ratio. This ratio is normally suitable for maximum power operation. However, under some circumstances it may be desirable to employ means that are adapted to change the air-fuel ratio in accordance with certain engine operating conditions. For example, it may be desirable to temporarily increase the quantity of fuel distributed to the engine cylinders during the starting operation. This is particularly true where the injection system requires a pump producing a considerable fuel pressure since such pumps are usually difficult to prime, and, consequently, have an inadequate pressure at the low cranking speeds.

It is now proposed to provide an enrichment means for a fuel injection system which will supplement the normal metering action and thereby insure an adequate supply of fuel for distribution to the engine cylinders at all times. This is to be accomplished by providing a fuel injection system having a low pressure, high volume transfer pump and a high pressure injector pump. The enrichment means are adapted to interconnect the output of the transfer pump directly with the low pressure portion of the system anterior to the flow restricting portions of the system. Thus the low pressure easily primed transfer pump will insure a large volume of fuel for distribution to the cylinders even during the cranking operation.

In the drawings:

Figure 1 is a diagrammatic view of a fuel injection system embodying the present invention.

Figure 2 is a cross sectional view of the metering and distributing mechanism employed in the fuel injection system of Figure 1 and taken along the plane of line 2—2 of Figure 3.

Figure 3 is a cross sectional view taken substantially along the plane of line 3—3 in Figure 2.

Referring to the drawings in more detail the present invention may be adapted for use in a fuel injection system 10 adapted to be employed on any suitable internal combustion engine 12. In the present instance the engine 12 is of the so-called V-type having a pair of angularly disposed banks of cylinders 14. Cylinder heads 16 are secured to each of the banks to close the upper ends of the cylinders 14 and form combustion chambers 18. An induction system 20 may be provided for charging the cylinders 14. This induction system 20 includes a plurality of induction passages 22 that communicate with

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the cylinders 14 for charging them and a throttle valve for regulating the volume of the charge.

The present fuel injection system 10 employs a fuel storage tank 24, a transfer pump 26, an injector pump 28, a metering mechanism 30 and a plurality of injector lines 52 that radiate from this mechanism 30 and have injector nozzles 34 on the outer ends thereof that are disposed in the induction passages 22 for spraying the metered fuel into the charges for cylinders 14.

Although the transfer pump 26 may be of any suitable type capable of delivering adequate quantities of fuel at adequate pressure, it has been found desirable to employ a so-called diaphragm pump. Such a pump may be driven by the engine and although the pressure of the fuel discharged therefrom is comparatively low, the volume of fuel will be large even at slow pumping speeds. It has been found desirable to maintain the transfer pump 26 as low as possible compared to the storage tank 24 so that the pump 26 will be easily primed and the likelihood of vapor formation will be reduced.

The injector pump 28 has the inlet thereof interconnected with the outlet of the transfer pump 26 and thereby receives the fuel therefrom under pressure. The outlet of the injector pump 28 is connected to the inlet 29 of the metering mechanism 30 and it pumps the fuel through the system 10. The injector pump is required to discharge fuel under a comparatively high pressure and in a volume in excess of the fuel requirements of the engine 12. It should be capable of delivering a constant volume of fuel per engine revolution so that it may be driven by the engine and has an output in direct proportion to the speed thereof. A constant volume elastomer plunger type pump has been found satisfactory for this purpose. The metering mechanism 30 includes a housing having an inlet chamber 36 in the bottom thereof which communicates with the inlet 29 so that the fuel from the injector pump 28 will flow into the inlet chamber 36. If desired, a suitable filter unit 38 may be provided in the inlet chamber 36 to filter any foreign material from the fuel.

A passage may extend upwardly from the inlet chamber 36 so as to form an opening 40 into the bottom of a spill fuel chamber 42. A tapered needle valve 44 may be provided in the opening in the upper end of the passage and a pressure responsive check valve 46 may be provided in the lower end so as to define a distributing chamber 48. A plurality of radial passages 50 may intersect the distributing chamber 48 at substantially equally spaced intervals and at equal angles. Injector lines 32 may radiate from these passages 50 and have nozzles 34 on the outer ends thereof which inject the metered fuel into the charge in the induction passages 22. This check valve 46 is pressure responsive to maintain the pressure upstream thereof, i. e., the inlet chamber 36, injector pump 28 etc., sufficiently high to substantially eliminate the formation of any fuel vapors anterior thereto. The check valve 46 will also be one way to allow fuel to flow from the inlet chamber 36 to the distributing chamber 48 but to prevent a flow in the reverse direction. Consequently, if any vapors form in the distributing chamber 48 and/or in the injector lines 52, the vapors will be prevented from backing up into the inlet chamber 36 and fuel pumps to form a vapor block.

In order to meter the quantity of fuel distributed through the injector lines 52 and into the charges for the cylinders 14, means may be provided that are responsive to the fuel demands of the engine 12 for actuating the by-pass needle valve 44 to thereby by-pass the surplus fuel from the distributing chamber 48 for return through the spill fuel line 55. In the present instance this means includes a diaphragm 56 that forms a diaphragm chamber

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58 that is interconnected with the induction system 20 so that the diaphragm 56 will be exposed to intake vacuum. A pair of opposed springs 60 and 62 on the opposite sides of the diaphragm 56 exert a biasing force thereon that will cause the needle valve 44 to assume a definite position for any given density of the charge. Thus since the injector pump 28 will deliver a substantially fixed amount of fuel to the distributing chamber 48 per revolution of the engine 12, if the needle valve 44 is properly tapered, the fuel distributed to the cylinders 14 will be metered in proportion to the air flow.

During certain operating conditions such as starting it may be desirable to provide means for temporarily changing the proportions of the charge and provide a richer more easily ignitable charge. Accordingly, suitable enrichment means 63 may be provided that will allow an additional supply of fuel to be distributed to the cylinders 14. The present means includes a fuel line 66 that has one end thereof connected to the output of the transfer pump 26. The opposite end of the fuel line 66 is connected to a fitting 72 in the side of the metering mechanism 30. This fitting 72 communicates directly with a filter 73 and a diagonal passage 74 that intersects the side of the radial passage 75. This passage 75 is radial to the axis of the distributing chamber 48 and it intersects the chamber immediately anterior to the check valve 46. The passage 75 may be threaded to receive an enrichment valve housing 68. A valve 76 is disposed inside of the housing 68 and a spring 77 biases the valve 76 to a normally closed position. Thus valve 76 will thereby normally prevent the flow of any fuel therpast. However, the valve 76 may be connected to a manual or automatic means 70 that is effective for opening this valve 76 when enrichment of the charge is required.

During normal operation the valve 76 will be retained closed. Thus all of the fuel supplied to the distributing chamber 48 will be from the injector pump 28. As a result the diaphragm 56 and needle valve 44 will be responsible for metering the fuel flow and the air and fuel will flow in some predetermined proportions. However, during the starting operation of the engine 12, the injector pump 28 may not be primed and/or incapable of developing sufficient pressure at the low cranking speeds to open the check valve 46 and force the fuel through the system. Accordingly, the valve 76 may be opened to insure an easily ignitable charge suitable for starting. Opening valve 76 will allow the fuel from transfer pump 26 to flow directly into the distributing chamber 48. Since this fuel enters the distributing chamber 48 anterior to the check valve 46, it will not be required to open the check valve 46 and will be flowing into a zone of low pressure. Thus the low pressure of pump 26 will be adequate to distribute the fuel to the cylinders 14 even at the slow cranking speeds occurring at starting. As soon as the engine fires and attains normal operating speeds the valve 68 is closed to restore normal metering action.

We claim:

1. A fuel injection system for an internal combustion engine having a plurality of cylinders, said injection system comprising pumping means, metering means having an inlet portion connected to said pump means and a distributing portion adapted to be connected to fuel nozzles for injecting the metered fuel into the induction system of said engine, said inlet portion and said distributing portion being interconnected with each other by a pressure responsive check valve adapted to maintain the pressure of the fuel in said inlet portion above the fuel pressure in said distributing portion, enrichment means adapted to temporarily interconnect said pumping means directly with said distributing portion anterior to said check valve.

2. A fuel injection system for an internal combustion engine having a plurality of cylinders, said injection system comprising a transfer pump, an injector pump con-

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nected to the outlet of said transfer pump, metering means having an inlet portion connected to said pump means and a distributing portion adapted to be connected to fuel nozzles for injecting the metered fuel into the induction system of said engine, said inlet portion and said distributing portion being interconnected with each other by a pressure responsive check valve adapted to maintain the pressure of the fuel in said inlet portion above the fuel pressure in said distributing portion, enrichment means adapted to temporarily interconnect the outlet of said transfer pump with said distributing portion anterior to said check valve for temporarily increasing the amount of fuel distributed to said cylinders.

3. A fuel injection system for an internal combustion engine having a plurality of cylinders and an induction system for charging said cylinders, said injection system comprising a transfer pump, an injector pump connected to the outlet of said transfer pump and driven by said engine to have an output proportional to the speed of said engine, metering means having an inlet portion connected to said injector pump and a distributing portion adapted to be connected to fuel nozzles for injecting metered fuel into said induction system, means responsive to the vacuum in said induction system to meter the fuel flow to said cylinders in some predetermined proportions to the charge by by-passing the surplus portion of the fuel, enrichment means for temporarily interconnecting the outlet of said transfer pump directly with said distributing portion for supplying a surplus of fuel thereto to temporarily increase the proportions of fuel to the charge.

4. A fuel injection system for an internal combustion engine having a plurality of cylinders and an induction system for charging said cylinders, said injection system comprising a transfer pump, an injector pump connected to the outlet of said transfer pump and driven by said engine to have an output proportional to the speed of said engine, metering means having an inlet portion connected to said injector pump and a distributing portion adapted to be connected to fuel nozzles for injecting metered fuel into said induction system, said portions being separated from each other by a pressure responsive check valve adapted to maintain the pressure of the fuel anterior thereto higher than the pressure posterior thereto, means responsive to the vacuum in said induction system to meter said fuel flow to said cylinders in some predetermined proportions to the charge by by-passing the surplus portion of the fuel, enrichment means for temporarily interconnecting the outlet of said transfer pump with said distributing portion anterior to said check valve for supplying a surplus of fuel thereto to temporarily increase the proportion of fuel to the charge.

5. A fuel injection system for an internal combustion engine having a plurality of cylinders and an induction system for charging said cylinders, said injection system comprising a transfer pump, an injector pump connected to the outlet of said transfer pump and driven by said engine to have an output proportional to the speed of said engine, metering means having an inlet portion connected to said injector pump and a distributing portion adapted to be connected to fuel nozzles for injecting metered fuel into said induction system, a by-pass valve in said distributing portion effective to meter the volume of distributed fuel by by-passing the surplus fuel, means responsive to the vacuum in said induction system to actuate said by-pass valve and maintain said fuel and the charge in some predetermined proportions, enrichment means for temporarily interconnecting the outlet of said transfer pump to said distributing portion for supplying a surplus of fuel thereto for temporarily increasing the proportions of fuel to the charge.

6. A fuel injection system for an internal combustion engine having a plurality of cylinders and an induction system for charging said cylinders, said injection system comprising a transfer pump, an injector pump connected

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to the outlet of said transfer pump and driven by said engine to have an output proportional to the speed of said engine, metering means having an inlet portion connected to said injector pump and a distributing portion adapted to be connected to fuel nozzles for injecting metered fuel into said induction system, a pressure responsive check valve separating said portions from each other to maintain the pressure of the fuel anterior thereto higher than the pressure posterior thereto, a by-pass valve in said distributing portion effective to meter the volume of distributed fuel by by-passing the surplus fuel, means responsive to the vacuum in said induction system to actuate said by-pass valve and maintain said fuel and the charge in some predetermined proportions, enrichment means for temporarily interconnecting the outlet of said transfer pump to said distributing portion anterior to said check valve for supplying a surplus of fuel thereto for temporarily increasing the proportions of fuel to the charge.

7. A fuel injection system for an internal combustion engine having a plurality of cylinders, said injection system comprising pumping means, metering means having an inlet portion connected to said pump means and a distribution portion adapted to be connected to fuel nozzles for injecting the metered fuel into the induction system of said engine, said inlet portion and said distribution portion being interconnected with each other by a pressure responsive check valve adapted to maintain the pressure of the fuel in said inlet portion above the fuel pressure in said distributing portion, a by-pass valve in said distributing portion to meter the distributed fuel by by-passing the surplus fuel, means responsive to the fuel demands of said engine to actuate said valve and maintain the fuel in some predetermined proportions to the

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charge, enrichment means for temporarily interconnecting the pumping means with said distributing portion anterior to said check valve for supplying a surplus of fuel thereto to temporarily increase the proportion of fuel to the charge.

8. A fuel injection system for an internal combustion engine having a plurality of cylinders, said injection system comprising a transfer pump having an outlet for discharging fuel therefrom, an injector pump having the inlet thereof connected to said outlet, metering means having an inlet portion connected to said injector pump outlet and a distribution portion adapted to be connected to fuel nozzles for injecting the metered fuel into the induction system of said engine, said inlet portion and said distributing portion being interconnected with each other by a pressure responsive check valve adapted to maintain the pressure of the fuel in said inlet portion above the fuel pressure in said distributing portion, a by-pass valve in said distributing portion to meter the distributed fuel by by-passing the surplus fuel, means responsive to the fuel demands of said engine to actuate said valve and maintain the fuel in some predetermined proportions to the charge, enrichment means for temporarily interconnecting the outlet of said transfer pump with said distributing portion anterior to said check valve for supplying a surplus of fuel thereto to temporarily increase the proportion of fuel to the charge.

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