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F. BARFOD
FUEL SUPPLY SYSTEM

3,019,779

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2 Sheets-Sheet 1

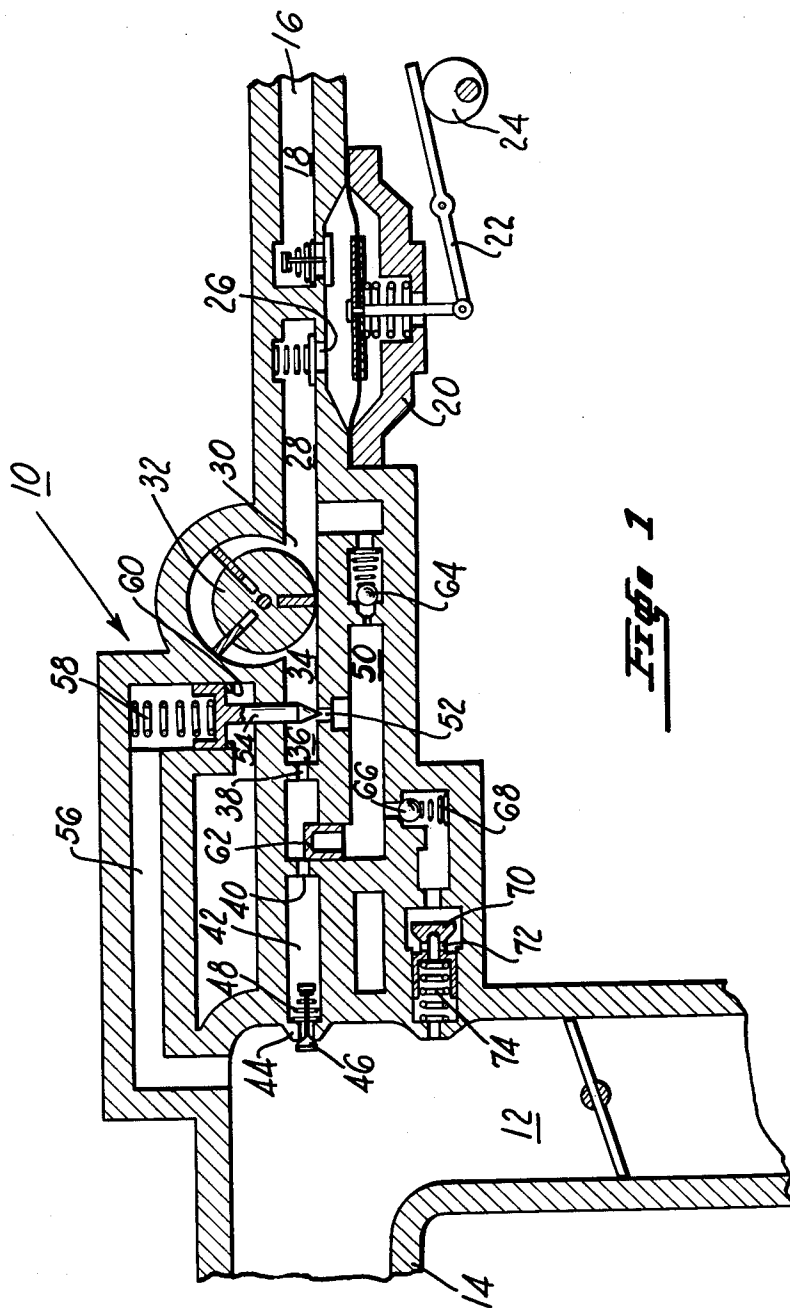


Figure 1

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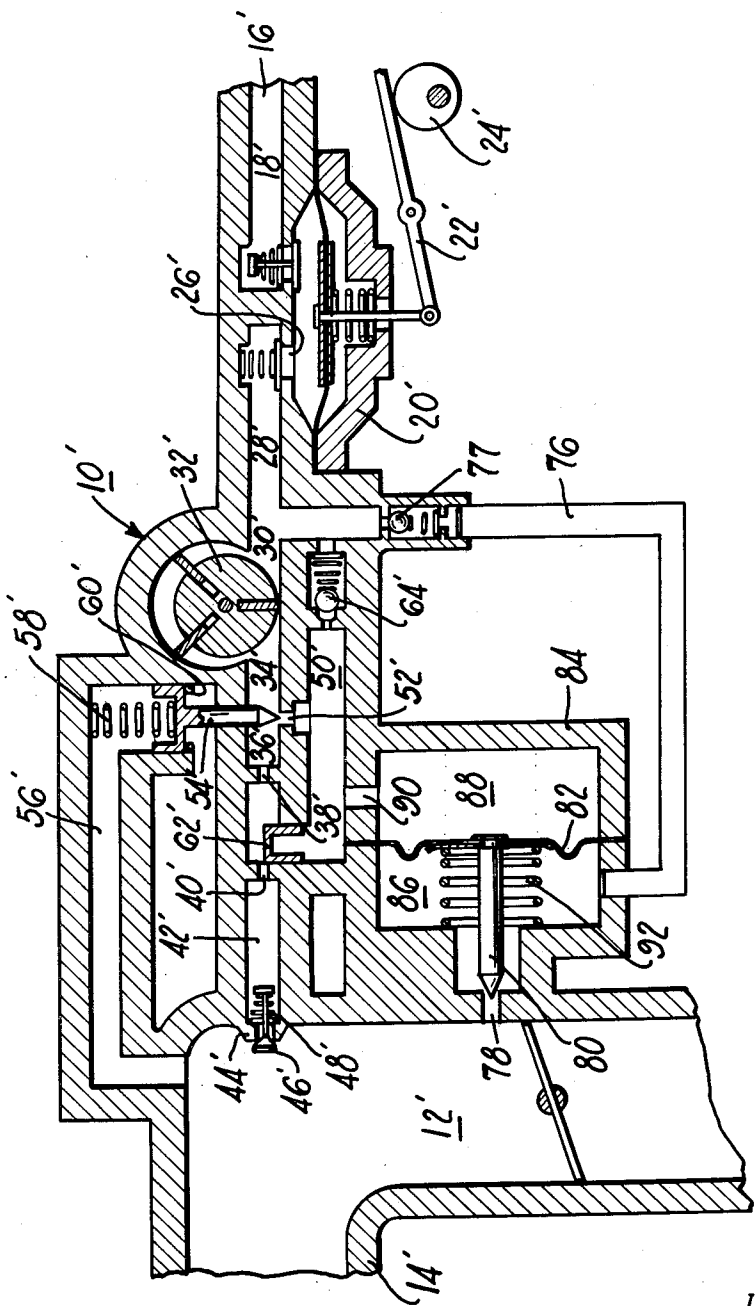


Fig. 2

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FUEL SUPPLY SYSTEM

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The present invention relates generally to fuel supply systems for supplying fuel under pressure to the induction passage of an internal combustion engine and more particularly to means for supplying fuel to the induction passage during the cranking or starting period of engine operation and/or low speed engine operation.

In fuel supply systems wherein the discharge nozzle or nozzles are provided with spring loaded valves, a minimum predetermined fuel pressure is required to open the valves. During engine cranking or low speed operation, engine driven pumps generally are incapable of creating the minimum pressure required to open the valves in the discharge nozzles. This is the case even though the spring loading on the valves is reduced to a minimum consistent with the prevention of dribbling from the nozzles and maintenance of sufficient pressure in the fuel lines upstream of the nozzles to prevent or minimize the formation of vapor. It has been proposed to use an electric driven supply pump which functions independently of engine speed to supply fuel under sufficient pressure to open the nozzle valves. This proposal is however relatively expensive and creates a substantial drain on the battery. In most modern vehicles (land, marine or air) the battery is either incapable or at best marginally capable of handling the drain of electric current to operate an electric supply pump and at the same time operate the engine starting motor. Thus the proposal to use an electric driven supply pump has not been successful.

In the present invention the fuel supply system may use a conventional, low cost, engine driven diaphragm type supply pump for supplying fuel to an engine driven positive displacement pump which discharges fuel to a metering system for ultimate discharge through spring loaded nozzle valves. A separate discharge conduit is provided to by-pass the normal discharge nozzles. This separate conduit is provided with a valve means which permits fuel flow therethrough during a range of low fuel pressures and is closed automatically when the fuel pressure is sufficiently high to open the main discharge nozzles.

The design and method of operation and the advantages obtained by the present invention will be described more in detail with reference to the accompanying drawings wherein:

FIGURE 1 is a schematic view of a fuel supply system embodying the present invention; and

FIGURE 2 is a partial view of FIGURE 1 showing another embodiment of the invention.

Referring now to the drawings numeral 10 is a fuel supply system for supplying fuel to the induction passage 12 of an internal combustion engine a fragment of which is shown at 14. The fuel supply system 10 is provided with an inlet 16 which is adapted for connection with a fuel tank or source of fuel (not shown). Inlet 16 is connected by means of conduit 18 to a diaphragm type supply pump 20 which is actuated by rocker arm 22 which in turn is actuated by an engine driven cam 24. The outlet 26 of pump 20 is connected by means of conduit 28 to the inlet 30 of an engine driven positive displacement pump 32. The outlet 34 of pump 32 is connected by means of conduit 36, restrictions 38 and 40, conduit 42 to a discharge nozzle 44. The discharge nozzle 44 is provided with a valve 46 which is urged toward closed position by a spring 48. In a specific embodiment spring 48 is selected to require a 40 p.s.i. fuel pressure in conduit 36 to open valve 46. A passage means 50 connects conduit 28 (be-

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tween pumps 20 and 32) to the induction passage 12. A restriction 52 connects conduit 36 with passage 50 and is controlled by a valve 54 which is rendered responsive to induction passage pressure through conduit 56. A spring 58 urges valve 54 downwardly to close restriction 52. An abutment or stop 60 is provided to limit the closing movement of valve 54 and thus insure a minimum flow area through restriction 52. A cylindrical valve 62 controls the area of metering restriction 40 and is disposed as to be movable in response to the pressure differential between the pressure in conduit 36 and passage 50. A check valve 64 is located in passage 50 to permit fuel to be by-passed from conduit 36 via restriction 52, passage 50 to conduit 28 when the pressure in passage 50 has reached a predetermined value. A second check valve 66 is provided in passage 50 to close the passage when the engine is stopped to prevent fuel from draining from the fuel supply system 10 into the induction passage. The spring 68 urging check valve 66 toward closed position is selected to permit the check valve 66 to open upon the actuation of pump 20 such as during the cranking of the engine during engine starting. Downstream of check valve 66 is located a cylindrical valve 70 which is provided with radially disposed ports 72. A spring 74 urges valve 70 toward open position. When the fuel pressure in passage 50 reaches a predetermined value valve 70 is moved in opposition to spring 74 to the left into closed position.

Operation

In the operation of the fuel supply system described thus far, the diaphragm supply pump 20 places the fuel in conduit 28 under pressure at a substantially constant value of 5 to 6 pounds. Until the engine is turning over sufficiently fast to permit pump 32 to increase the supply pump pressure sufficiently to open the discharge nozzle valve 46, fuel is supplied to the induction passage through conduit 36, restriction 52, passage 50, check valve 66 and valve 70. The spring 74 is selected to permit valve 70 to close when the pressure in conduits 36 and 42 is sufficiently high to open the main discharge nozzle valve 46. With the valve 70 closed the fuel supply system operates as more fully disclosed and claimed in my copending application 604,483 filed August 16, 1956 and now Patent No. 2,930,370, granted Mar. 29, 1960 to supply metered fuel to the engine.

Referring now to the embodiment shown in FIGURE 2 wherein primed numerals have been used to designate similar parts. The outlet 26' of supply pump 20' is connected to the induction passage 12' through conduit 28', passage means 76, check valve 77 and restriction 78. A valve 80 is secured to the central portion of the diaphragm 82 and is operative to control the flow through restriction 78. Diaphragm 82 is marginally clamped in a housing 84 to divide the interior thereof into chambers 86 and 88. Chamber 88 is exposed to the outlet pressure of pump 32' through conduits 36', restriction 52', passage 50' and conduit 90. Chamber 86 is exposed to the inlet pressure to pump 32' via conduit 76. A spring 92 is disposed in chamber 86 to urge diaphragm 82 in a direction to open valve 80. Valve 80 is urged toward closed position when the outlet pressure in chamber 88 exceeds the inlet pressure in chamber 86 by an amount as predetermined by the force of spring 92.

While I have herein illustrated preferred embodiments of my invention it readily will be understood that changes, modifications and substitutions may be made therein without departing from the spirit and scope of my invention.

I claim:

1. In a fuel supply system for an internal combustion engine having an induction passage and a source of fuel, a nozzle in said induction passage, a valve in said nozzle, spring means urging said valve toward closed position, con-

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duit means connecting said nozzle with said source of fuel, a supply pump in said conduit means, a second pump in said conduit means downstream of said supply pump for placing fuel under a pressure which varies as a function of engine speed, passage means connecting said induction passage to said conduit means between said nozzle and said second pump, and valve means responsive to the pressure differential across said second pump for controlling the flow through said passage means.

2. In a fuel supply system for an internal combustion engine having an induction passage and a source of fuel, a nozzle in said induction passage, a valve in said nozzle, spring means urging said valve toward closed position, conduit means connecting said nozzle with said source of fuel, a supply pump in said conduit means, a second pump in said conduit means downstream of said supply pump for placing fuel under a pressure which varies as a function of engine speed, passage means connecting said induction passage to said conduit means between said nozzle and said second pump, a first valve in said passage means movable to open position in response to a predetermined fuel pressure in said passage means, a second valve in said passage means downstream of said first valve movable to closed position in response to a predetermined fuel pressure greater than said first mentioned fuel pressure and spring means respectively urging said first and second valves closed and opened.

3. In a fuel supply system for an internal combustion engine having an induction passage and a source of fuel, conduit means adapted to connect said source to said induction passage, a supply pump in said conduit means, a second pump in said conduit means downstream of said

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supply pump for placing fuel under a pressure which varies as a function of engine speed, a valve in said conduit means responsive to the pressure differential across said second pump, and resilient means urging said valve toward opened position, said valve being urged toward closed position when the outlet pressure to said second pump exceeds the inlet pressure of said second pump by a predetermined amount.

4. In a fuel supply system for an internal combustion engine having an induction passage and a source of fuel, a nozzle in said induction passage, a valve in said nozzle, spring means urging said valve toward closed position, conduit means adapted to connect said source of fuel to said nozzle, a low pressure supply pump in said conduit means, a positive displacement pump driven as a function of engine speed disposed in said conduit means downstream of said supply pump, a passageway connecting said conduit means intermediate said pumps with said induction passage, a valve in said passageway, a movable wall operatively connected to said last mentioned valve, means for subjecting one side of said wall to fuel at inlet pressure of the positive displacement pump to urge said last mentioned valve toward open position, means for subjecting the opposite side of said movable wall to fuel at outlet pressure of the positive displacement pump to urge said last mentioned valve toward closed position, and spring means urging said last mentioned valve toward opened position.

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