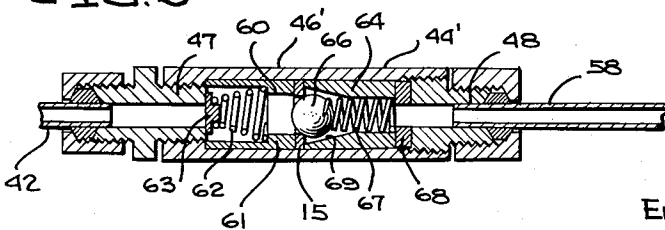


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2 Sheets-Sheet 1



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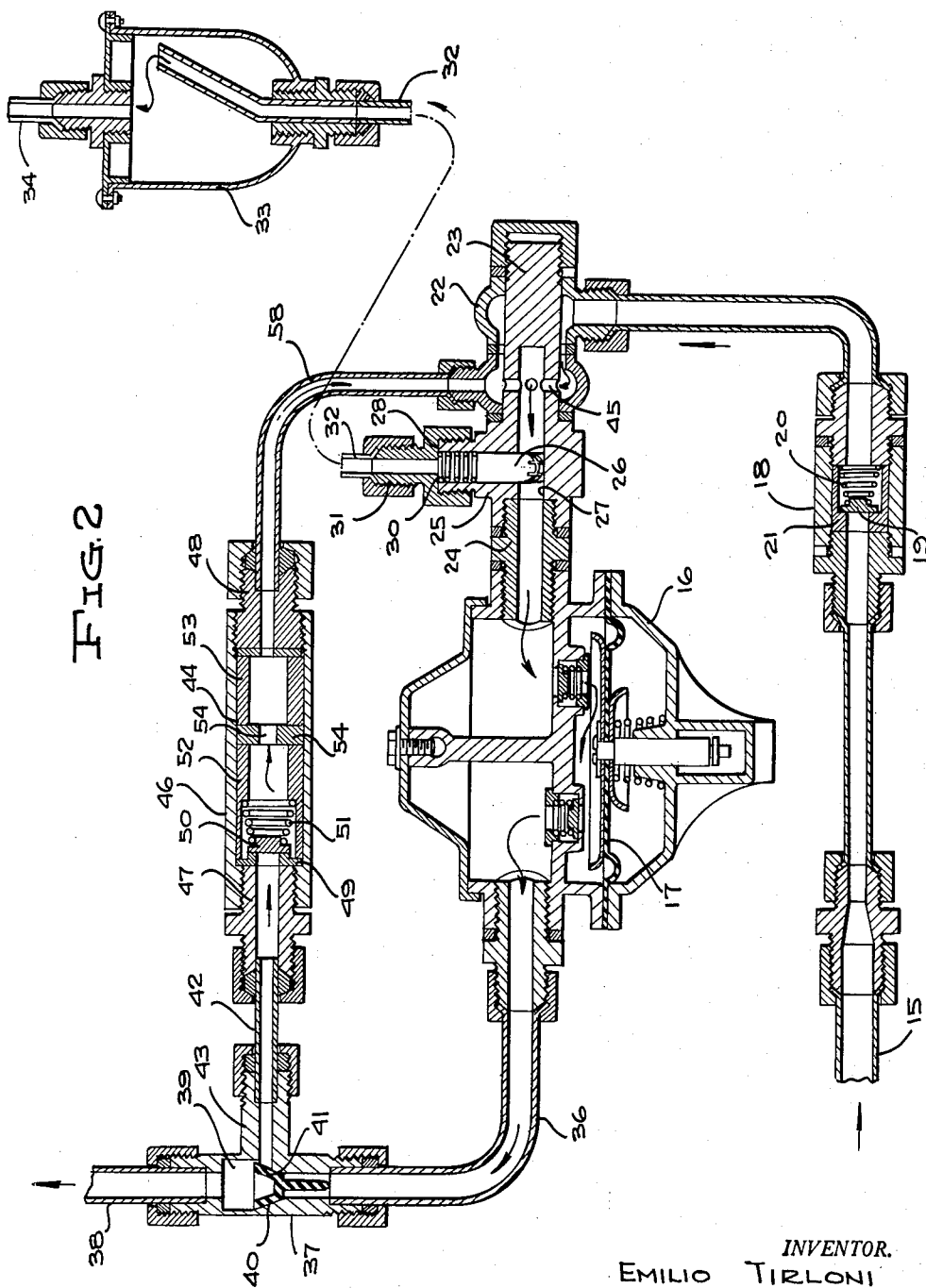
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FUEL SUPPLY SYSTEM FOR AN INTERNAL COMBUSTION ENGINE

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FUEL SUPPLY SYSTEM FOR AN INTERNAL COMBUSTION ENGINE

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8 Claims. (Cl. 123—139)

This invention relates to internal combustion engines, and more particularly to a novel and improved fuel supply system for an engine.

A main object of the invention is to provide a novel and improved fuel supply system for an internal combustion engine, said system involving relatively simple components, being easy to install, and being arranged so as to regulate the fuel mixture supplied to the engine in accordance with the speed of the engine, whereby to produce efficient utilization of the fuel and to insure that fuel will be available to take care of the load imposed on the engine under a wide range of operating conditions.

A further object of the invention is to provide an improved fuel supply system for an internal combustion engine, said system involving inexpensive components, being reliable in operation, and being arranged so as to utilize the inertia of the moving fuel furnished to the carburetor to distribute the fuel to the best advantage, while at the same time providing sufficient fuel in the float chamber of the carburetor at all times to insure that the engine can accelerate under load, as required.

A still further object of the invention is to provide an improved fuel supply system for an internal combustion engine which is adapted for installation on existing engines without requiring any substantial modification thereof, which provides greatly increased flexibility of performance of the engine, and which greatly increases the economy of consumption of the fuel supply to the engine, as well as insuring proper and efficient performance thereof.

Further objects and advantages of the invention will become apparent from the following description and claims, and from the accompanying drawings, wherein:

Figure 1 is a side elevational view of an internal combustion engine provided with an improved fuel supply system constructed in accordance with the present invention.

Figure 2 is an enlarged longitudinal vertical cross sectional view taken through the fuel pump, bypass conduit, and portions of the fuel line adjacent thereto, as employed in the system of Figure 1.

Figure 3 is an enlarged longitudinal vertical cross sectional view of a variable restriction device which may be employed in the bypass conduit of the fuel system of Figures 1 and 2 in place of the fixed restriction device illustrated therein.

Figure 4 is a fragmentary elevational view of a further modified form of variable restriction arrangement which may be employed in the bypass conduit of a fuel supply system according to the present invention.

Referring to the drawings, and more particularly to Figures 1 and 2, 11 generally designates an internal combustion engine, for example, an engine provided in a motor vehicle, the engine 11 having an intake manifold 12 and a carburetor 13 connected in the usual way to the intake manifold so as to supply a mixture of air and liquid fuel to said manifold. Associated with the internal combustion engine 11 is a fuel reservoir 14 which is con-

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nected to the carburetor 12 by a fuel supply line 15. Connected in the fuel supply line is a conventional fuel pump 16 which is operated by the engine in a well known manner and which may be of the type provided with a flexible reciprocating diaphragm 17, as illustrated in Figure 2.

As shown in Figure 2, the fuel supply line 15 is provided with a normally closed check valve 18 connected between the fuel pump and the reservoir 14, the check valve 18 comprising a spring biased valve disc 19 which is normally held in seating relationship in the valve by a coiled spring 20 and which opens responsive to suction developed in the fuel line by the action of the fuel pump 16, so as to allow liquid fuel to flow through the line from the supply reservoir 14 toward the inlet side of the fuel pump. When the fuel pump 16 is not operating the valve disc 19 is held against its seat 21, thereby sealing the fuel line from the inlet side of fuel pump 16.

The outlet of the check valve 18 is connected to the intermediate portion of a substantially annular chamber 22 in which is threadedly engaged a horizontal stem member 23, which is in turn threadedly engaged on the inlet fitting 24 of the fuel pump 16. The stem member 23 is formed with a cylindrical plunger casing 25 which slidably supports a valve plunger 26, said plunger 26 normally sealing the bore 27 of the stem member 23 by the biasing action of a coiled spring 28 provided in the chamber 25 above the plunger 26. Spring 28 bears between the top end of the plunger 26 and the annular shoulder 30 defined by a cap member 31 threadedly engaged on the top portion of the cylindrical casing 25. Connected to the annular cap member 31 is a conduit 32 which leads to a vacuum chamber 33 mounted on the engine 11 and connected at its top end to the intake manifold 12 by a conduit 34.

The valve plunger 26 is normally held in sealing engagement in the bore 27 but opens responsive to vacuum in the chamber 33, namely, when the engine 11 is operated for example, when the engine is started by means of its starting motor and thereafter, whereby the intake manifold 12 produces a vacuum action.

The outlet side of the fuel pump 16 is connected through a conduit segment 36, a T-fitting 37 and an additional conduit segment 38 to the carburetor 13. The stem of the T-fitting 37 communicates with a valve chamber 39 formed in the fitting, and provided with a conical seat 40 on which is supported a relatively flexible valve element 41, which is preferably made of rubber or other similar resilient deformable material, the valve element 41 acting as a check valve and normally sealing off the T-fitting 37 at the intermediate portion thereof, as shown in Figure 2. The hollow conical top portion of the valve element 41 is readily deformable, for example, in response to the pressure in the liquid furnished from the outlet side of the fuel pump 16, said valve element 41 being thus inwardly deformable sufficiently to allow the liquid to flow therepast through the chamber 39 and through the conduit segment 38 to the carburetor 13 in response to the pressure developed by the fuel pump 16.

As shown, the stem portion of the T-fitting communicates with the main body portion thereof at the valve seat 40. A bypass conduit 42 is connected between the stem portion 43 of the T-fitting 37 and the annular chamber 22 surrounding the outer portion of the stem member 23. The bypass conduit 42 is provided with a flow-restricting device, indicated generally at 44 so as to control the amount of liquid fuel bypassed around the fuel pump 16. As shown, the stem member 23 is formed with a plurality of radial apertures 45 which establish communication between the chamber 22 and the inside bore 27 of the stem member, allowing the bypass liquid fuel to pass into the inlet side of pump 16 for recircula-

tion through the pump and the outlet conduit means associated therewith.

The restriction device 44 comprises a main, generally cylindrical housing 46 provided with respective annular end conduit fittings 47 and 48, to enable the device to be connected in the bypass conduit 42, as shown in Figure 2. The housing 46 is provided with an annular valve seat 49 against which is urged an annular check valve disc 50, the disc 50 being biased into seating engagement with the stationary annular valve seat 49 by a coiled spring 51 bearing between disc 50 and the end of a cylindrical spacer sleeve 52 provided in housing 44. Positioned between the spacer sleeve 52 and a further spacer sleeve 53 is an annular flow-restricting disc member 54, said disc member being provided with a central aperture 55 which is calibrated to provide a predetermined amount of restriction to the flow of the bypass liquid passing through the bypass conduit 42, the aperture 55 being dimensioned in accordance with the particular characteristics of the engine 11 with which the system is employed.

In operation, when the engine 11 is operating, vacuum will be developed in its intake manifold 12, causing the plunger 26 to be elevated, and thus maintaining clearance in the stem member 23 for the passage of fuel to the inlet side of the fuel pump 16. The fuel pump produces suction which causes the fuel to flow past the valve disc 19 of check valve 18 and to pass into the chamber 22, passing through the apertures 45 and past the elevated valve plunger 26 into the inlet fitting 24 of the fuel pump. The fuel is delivered to the outlet side of the fuel pump 16 through the conduit segment 36 and past the deformable valve element 41 to the conduit segment 38, a portion of the fuel circulating through the bypass conduit 42 and the restriction device 44 and passing from the restriction device 44 through a conduit segment 58 to the chamber 22. Fuel will be thus bypassed across the pump 16 when the engine conditions are such that an excess of fuel is being furnished to the carburetor 13, since the excess fuel supply pressure prevailing in the conduit 36 under these conditions will be sufficient to cause the bypass fuel passing through the conduit 42 to open the check valve defined by the disc 50 and the stationary seat 49 against the force of the biasing spring 51. The fuel will then pass through the orifice 55, which thus serves as a limiting means to prevent too rapid a flow of bypass fuel across the pump 16. The bypass fuel passes into the chamber 22 through the conduit segment 58 and then recirculates through the fuel pump 16, along with as much additional fuel from the main supply conduit 15 as is required to meet the engine fuel demand under the prevailing conditions.

A different size of aperture 55 may be employed for different types of engines, and in accordance with different types of operating conditions which the engine may be called upon to meet. Thus, by selecting a relatively large aperture 55, the top speed of the engine may be limited, since a large aperture 55 will allow a relatively large amount of fuel to be bypassed across the fuel pump 16.

Since the restriction device 44 may be utilized as a means for controlling the performance of the engine and the character of its response to different types of loading conditions, the restriction device may be made to automatically readjust itself to different conditions so as to automatically vary the amount of bypass fuel in accordance with the fuel pressure developed at the outlet side of the fuel pump and the rate of flow of the main fuel supply through the conduit segment 38. Thus, as shown in Figure 3, the restriction device, designated at 44' may comprise a generally cylindrical housing 46' provided with the end conduit fittings 47 and 48, as employed in the previously described embodiment of the invention. The housing 46' contains a first annular spacer sleeve 60 which is shouldered at 61 to define an abutment against

which is positioned one end of a coiled spring 62. The other end of the coiled spring engages a check valve disc 63 which is thus urged toward sealing engagement with the inner end of the conduit fitting 47. A second sleeve member 64 is disposed in the housing 46' and cooperates with the first sleeve member 60 to position an annular valve disc 65 against which a valve ball 66 is urged by a coiled spring 67. The coiled spring 67 bears at one end on the ball 66 and at the other end on an annular abutment ring 68 located between the conduit fitting 48 and the sleeve member 64.

The sleeve member 64 is formed with the conical end cavity 69 in which the ball 66 is axially movable, the cavity 69 providing sufficient clearance to allow ball 66 to become disengaged from the ring member 65 and to allow fuel to flow therepast through the conduit fitting 48 into the conduit segment 58 in response to the pressure available in the bypass fluid. Excessive flow of the bypass liquid is prevented because of the restriction defined between the ball 66 and the conical surface 69, the restriction becoming more limited as the ball 66 moves away from the annular supporting ring 65. The spring 67 may be selected so as to provide a desirable amount of bypass flow, in accordance with the design of the internal combustion engine 11 in which the device is employed and in accordance with the particular type of response characteristics which is desired to provide for the engine. As will be readily apparent, if spring 67 is relatively yieldable, the ball 66 will tend to move closely against the conical surface 69, thus limiting the flow of bypass fuel to an extent such that a relatively high level of fuel will exist in the float tank of the carburetor 13, thus adapting the engine for operation under heavy loading conditions but thereby somewhat reducing fuel economy. Conversely, where the engine is not required to be constantly under heavy loading, the spring 67 may be made relatively stiff so as to allow a larger proportion of fuel to be bypassed around the fuel pump 16.

Referring now to Figure 4, an arrangement is disclosed wherein a plurality of restriction members 70, 71 and 72 are employed and are selectively connected into the bypass conduit 74 in accordance with the demand made upon the engine. Thus, a selecting valve 76 is connected between the T-fitting 37 and the bypass conduit, said selecting valve having respective outlet conduits 77 connected through the restriction devices 70, 71 and 72 to the remainder of the bypass conduit 74, whereby any selected one of the restriction member 70, 71 or 72 may be inserted in the bypass conduit in accordance with the position of the rotatable valve arm 78 which is operatively connected to the rotor of the multiple position valve 76. The arm 78 is connected by a flexible cable 79 to the accelerator pedal or to a part of the throttle operating mechanism of the engine, so that the arm 78 is automatically rotated in response to the actuation of the engine speed controlling member to which cable 79 is coupled. The respective restriction devices 70, 71 and 72 are provided with apertured restriction discs 54 having apertures of graduated size, and being arranged so that as the engine speed controlling member is moved in a position to increase the speed of the engine, a smaller aperture 55 is placed in the bypass conduit so as to reduce the amount of fuel bypassed across the fuel pump 16. Thus, when the engine is idling, or is under relatively slow speed conditions, a relatively large aperture 55 is presented in the bypass conduit, enabling a large percentage of the fuel delivered by pump 16 to be bypassed thereacross. Under high speed conditions a smaller aperture 55 is presented in the bypass conduit, allowing a greater percentage of the fuel delivered by pump 16 to be furnished to the carburetor 13, and allowing the level of fuel in the carburetor float tank to be maintained at a necessary value for these conditions.

If so desired, a ball type check valve such as that dis-

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closed in Figure 3 may be substituted for the disc-type check valve 18 shown in Figure 2, so as to provide the same type of flow restriction between the reservoir 14 and the fuel pump 16 as is provided by the device of Figure 3 in the bypass conduit.

While certain specific embodiments of an improved fuel supply system for an internal combustion engine have been disclosed in the foregoing description, it will be understood that various modifications within the spirit of the invention may occur to those skilled in the art. Therefore, it is intended that no limitations be placed on the invention except as defined by the scope of the appended claims.

What is claimed is:

1. In combination with an internal combustion engine having an intake manifold and a carburetor connected to said intake manifold, a fuel reservoir, a fuel supply line connecting said fuel reservoir to said carburetor, a fuel pump operatively connected in said fuel supply line, a normally closed suction-responsive valve in said supply line between the reservoir and the fuel pump, conduit means connecting said valve to said intake manifold and being constructed and arranged to open said valve responsive to vacuum in said manifold, and a fuel bypass conduit connected from the outlet side of said pump to a point in the line adjacent the inlet side of the pump.

2. In combination with an internal combustion engine having an intake manifold and a carburetor connected to said intake manifold, a fuel reservoir, a fuel supply line connecting said fuel reservoir to said carburetor, a fuel pump operatively connected in said fuel supply line, a normally closed suction-responsive valve in said supply line between the reservoir and the fuel pump, conduit means connecting said valve to said intake manifold and being constructed and arranged to open said valve responsive to vacuum in said manifold, and a fuel bypass conduit connected from the outlet side of said pump to a point in the line adjacent the inlet side of the pump, said valve being located between said point and the inlet of the pump.

3. In combination with an internal combustion engine having an intake manifold and a carburetor connected to said intake manifold, a fuel reservoir, a fuel supply line connecting said fuel reservoir to said carburetor, a fuel pump operatively connected in said fuel supply line, a normally closed suction-responsive valve in said supply line between the reservoir and the fuel pump, conduit means connecting said valve to said intake manifold and being constructed and arranged to open said valve responsive to vacuum in said manifold, and a fuel bypass conduit connected from the outlet side of said pump to a point in the line adjacent the inlet side of the pump, said bypass conduit including means defining a restriction to return flow of fuel through said bypass conduit.

4. In combination with an internal combustion engine having an intake manifold and a carburetor connected to said intake manifold, a fuel reservoir, a fuel supply line connecting said fuel reservoir to said carburetor, a fuel pump operatively connected in said fuel supply line, a normally closed suction-responsive valve in said supply line between the reservoir and the fuel pump, conduit means connecting said valve to said intake manifold and being constructed and arranged to open said valve responsive to vacuum in said manifold, a fuel bypass conduit connected from the outlet side of said pump to a point in the line adjacent the inlet side of the pump, and an apertured flow-restricting disc mounted in said bypass conduit.

5. In combination with an internal combustion engine having an intake manifold and a carburetor connected

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to said intake manifold, a fuel reservoir, a fuel supply line connecting said fuel reservoir to said carburetor, a fuel pump operatively connected in said fuel supply line, a check valve in the supply line between the pump and the carburetor, a normally closed suction-responsive valve in said supply line between the reservoir and the fuel pump, conduit means connecting said last-named valve to said intake manifold and being constructed and arranged to open said last-named valve responsive to vacuum in said manifold, and a fuel bypass conduit connected between a point in the supply line adjacent said check valve to a point in the line adjacent the inlet side of the pump.

6. In combination with an internal combustion engine having an intake manifold and a carburetor connected to said intake manifold, a fuel reservoir, a fuel supply line connecting said fuel reservoir to said carburetor, a fuel pump operatively connected in said fuel supply line, a check valve in the supply line between the pump and the carburetor, a normally closed suction responsive valve in said supply line between the reservoir and the fuel pump, conduit means connecting said last-named valve to said intake manifold and being constructed and arranged to open said last-named valve responsive to vacuum in said manifold, and a fuel bypass conduit connected from the outlet side of said pump to a point in the line adjacent the inlet side of the pump, said bypass conduit including means defining a restriction to return flow of fuel through said bypass conduit, said last-named valve being located between said last-named point and the inlet of the pump.

7. In combination with an internal combustion engine having an intake manifold, a fuel reservoir, a movable engine speed controlling member, and a carburetor connected to said intake manifold, a fuel supply line connecting said fuel reservoir to said carburetor, a fuel pump operatively connected in said fuel supply line, a normally closed suction-responsive valve in said supply line between the reservoir and the pump, conduit means connecting said valve to said intake manifold and being constructed and arranged to open said valve responsive to vacuum in said manifold, a fuel bypass conduit connected across the fuel pump, and means defining a variable restriction in said bypass conduit.

8. In combination with an internal combustion engine having an intake manifold, a fuel reservoir, a movable engine speed-controlling member, and a carburetor connected to said intake manifold, a fuel supply line connecting said fuel reservoir to said carburetor, a fuel pump operatively connected in said fuel supply line, a normally closed suction-responsive valve in said supply line between the reservoir and the pump, conduit means connecting said valve to said intake manifold and being constructed and arranged to open said valve responsive to vacuum in manifold, a fuel bypass conduit connected across the fuel pump, means defining a variable restriction in said bypass conduit, and means connecting said variable restriction means to said engine speed-controlling member and being constructed and arranged to regulate the effective size of the variable restriction means in accordance with the movement of said engine speed-controlling member.

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