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FUEL FEED SYSTEM FOR INTERNAL COMBUSTION ENGINES

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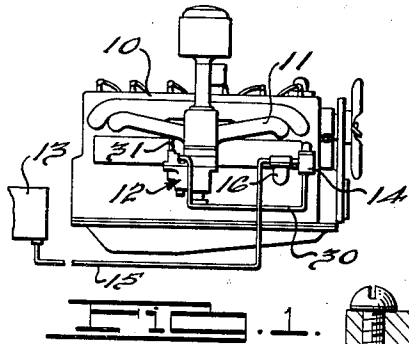


FIG. 2.

FIG. 3.

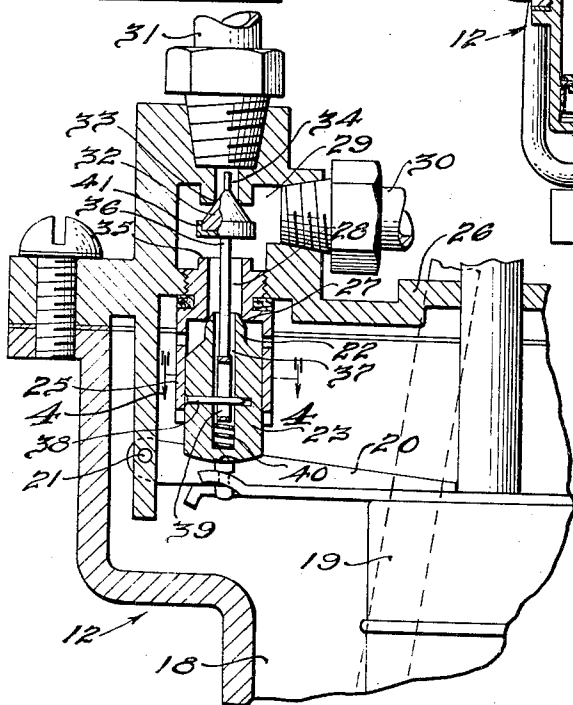
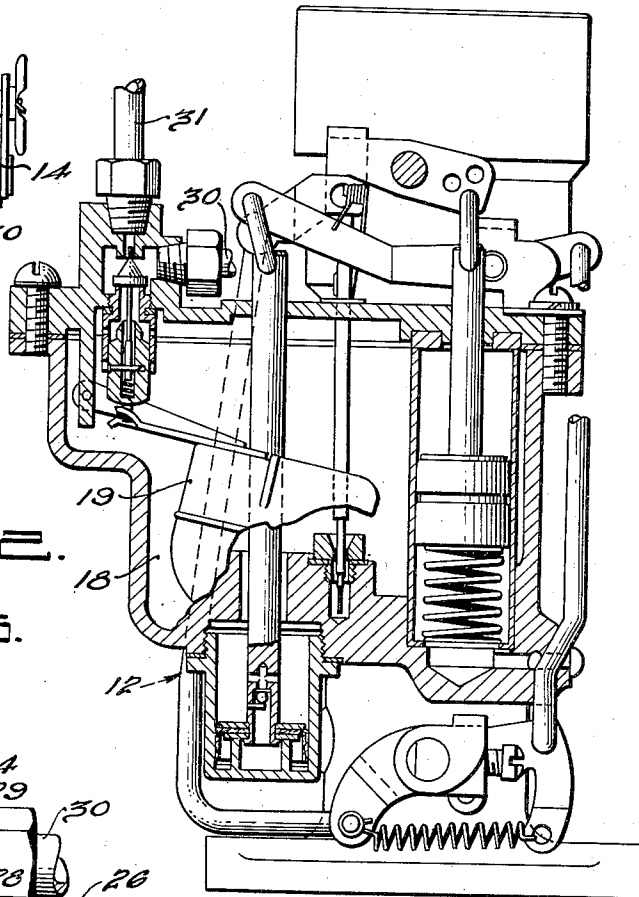
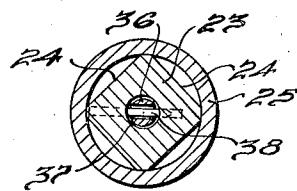


FIG. 4.

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FUEL FEED SYSTEM FOR INTERNAL COMBUSTION ENGINES

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6 Claims. (Cl. 123-119)

This invention relates to internal combustion engines and more particularly to fuel feed systems therefor.

Considerable difficulties due to irregularity of flow of the fuels have heretofore been experienced in operating internal combustion engines in which a highly volatile fuel as for example gasoline is delivered to the engine through a system of conduits. This difficulty is commonly referred to as "vapor lock" and is due to breaking the continuity of the flow of the fuel as a liquid in the fuel conduits. Usually this is occasioned by vaporization of the fuel in the conduits, the normal operation of the fuel feed means as well as fuel and air mixing devices is thus interrupted.

In the automotive field these so-called "vapor lock" phenomena have been frequent in hot weather in engines equipped with mechanically driven fuel pumps. With fuels having a low boiling point, the suction produced by the fuel pump in a conduit filled with the fuel causes the fuel to vaporize if the temperature conditions are such as to heat the fuel. The result is that breaks occur in the continuity of the liquid fuel stream and the pump fails to deliver a sufficiently continuous stream of liquid fuel to secure the desired operation of the carburetor. Since the amount of liquid fuel held in a carburetor is relatively small, it is used up rather quickly and the engine stalls within a short time after the vapor lock occurs in the line. When this happens, the engine cannot be started until sufficient time is allowed for the fuel feed conduits to cool down and the condensation of the vapor permits filling the conduits with liquid fuel to enable the pump to reestablish normal operation. The most frequent conditions under which the vapor locks occur are: maximum torque and low speed operation for a considerable length of time, maximum power operation for a long time during hot weather and with low boiling fuel, idling in heavy traffic, stopping for gasoline and standing for some time.

One of the objects of the present invention is to provide means which automatically eliminate the vapor lock conditions as they occur in the fuel feed conduits of an internal combustion engine without adversely affecting operation of the engine.

Another object of the invention is to provide an improved valve which enables removal of the vapor from the fuel feed conduits before the fuel in the float chamber of the engine carburetor is exhausted or drops to the level where suction action of the venturi of the carburetor is unable to draw the fuel through the jet.

It is a further object of the present invention to utilize the suction created during operation of an internal combustion engine to purge the fuel feeding system of vaporized fuel or other matter obstructing the flow of liquid fuel from the supply tank to the engine.

A further object of the present invention is to provide a liquid fuel feeding system for internal combustion engines which assures at all times a substantially uninterrupted flow of liquid fuel from the supply tank to the carburetor.

It is an added object of the invention to provide an improved device of the above character which is simple in construction and dependable in operation, and which is relatively inexpensive to manufacture.

Other objects and advantages of the invention will appear in the following description and appended claims, reference being had to the accompanying drawing forming a part of this specification, wherein two embodiments of the present invention are illustrated.

Fig. 1 is a diagrammatic view showing an internal combustion engine having a fuel feed system embodying the present invention.

Fig. 2 is a side view of a carburetor, partly in section, showing the vapor lock control valve in its open position.

Fig. 3 is a view showing in section a portion of the carburetor and the vapor lock control valve in its closed position.

Fig. 4 is a horizontal sectional view, looking in the direction of the arrows, the section being taken on the line 4-4 of Fig. 3.

Before explaining in detail the present invention it is to be understood that the invention is not limited in its application to the details of construction and arrangement of parts illustrated in the accompanying drawing, since the invention is capable of other embodiments and of being practiced or carried out in various ways. Also it is to be understood that the phraseology or terminology employed herein is for the purpose of description and not of limitation, and it is not intended to limit the invention claimed herein beyond the requirements of the prior art.

In the drawing there is shown, by way of example, an internal combustion engine having a fuel feed system embodying the present invention. Referring to Fig. 1, the structure illustrated therein comprises a gasoline engine 10 having a manifold 11 adapted to distribute to the various engine cylinders the combustible fuel mixture supplied thereto by the carburetor 12. The fuel feed system of the engine comprises a fuel supply res-

ervoir 13 and a fuel pump 14 of any desired type. The suction or the vacuum side of the fuel pump is connected to the fuel supply reservoir 13 by means of a conduit 15, a sediment bulb 16 being interposed between the fuel supply reservoir and the pump, preferably in close proximity to the pump, for the purpose of separating water and solid particles which may be contained in the gasoline. The discharge or pressure side of the pump 14 is connected with the carburetor 12. By virtue of such a construction the fuel from the reservoir 13 is drawn by the pump 14 and is delivered under a certain amount of pressure, usually from two to four pounds per square inch, to the carburetor wherein atomization and vaporization of the fuel is effected and it is mixed with a necessary amount of air to insure proper combustion in the engine. The fuel vapor and air mixture is delivered from the carburetor 12 to the intake manifold 11 because of the suction created in the cylinders by operation of the engine 10.

The carburetor 12 may be of any preferred type, as for example, the float type which includes a float chamber 18 communicating with a jet operatively disposed in the Venturi conduit (not shown) of the carburetor. The construction and operation of such devices are well known to those skilled in the art. In such a construction, a float 19 carried by a lever 20 hinged to the carburetor structure as indicated at 21 may be utilized to actuate a float chamber valve 22. The float chamber valve 22 has a cylindrical extension 23 milled at its four sides, as indicated at 24, and adapted to slide in a guiding cylinder 25 secured in any desired manner to the cover 26 of the float chamber 18. The valve 22 is adapted to cooperate with the seat 27 formed on the cylinder 25 and to open and close the orifice 28 leading into a valve chamber 29. Into the valve chamber 29 opens the discharge end of a conduit 30 leading from the pump 14.

The structure so far described is typical of conventional devices in which the "vapor lock" phenomenon seriously interferes with the satisfactory operation of the engine. From an examination of the drawing it can be easily appreciated that as the level of the liquid fluid in the float chamber decreases as fuel is drawn into the jet, the float 19 descends with the fuel level and opens the valve 22 to permit the fuel to fill the conduit 30. This builds up a supply of fuel under the required pressure to pass through the orifice 28 and the spaces formed between the milled portions 24 of the valve extension 23 and the guiding cylinder 25 into the float chamber, thereby replenishing the quantity of fuel contained therein. It is important to note at this instance that for the proper operation of the carburetor it is necessary that the fuel in the float chamber is maintained at a certain level, since the float chamber and the jet constitute communicating vessels, and the level of the fuel in the jet and the character of the fuel mixture are consequently dependent upon the level of the liquid fuel in the float chamber.

Should the fuel in the conduit 15 be heated above a certain temperature by any one of a variety of causes such for example as long exposure of the fuel reservoir 13 to sun rays, or heating the conduit 15 by engine exhaust conduits, the suction action of the pump 14 in combination with the heated fuel may cause vaporization of the fuel in the conduit 15. As vapors form in the conduit 15, the pressures break the conti-

nunity of liquid fuel therein and the pump draws only fuel vapor instead of liquid fuel. Since the fuel pump has a relatively small volume, which is filled by the vapor, it cannot deliver sufficient fuel to meet the requirements of the engine and the liquid fuel contained in the float chamber 18 and the delivery conduit 30 is soon exhausted, and the float chamber is emptied. The small amount of fuel vapor passing from the fuel pump to the fuel jet through the empty float chamber 18 is insufficient to provide a proper fuel mixture and, therefore, the engine ceases to operate efficiently or may stop entirely within a few minutes after a break of the continuity of liquid fuel occurs in the conduit 15.

In accordance with the present invention means are provided whereby the continuity of liquid fuel in the conduits 15 and 30 is assured and if any vapor lock condition occurs such continuity is reestablished before the float chamber empties. In the present embodiment of the invention such means include a by-pass conduit 31 connecting the valve chamber 29 directly with the intake manifold 11. A valve 32 cooperating with a seat 33 is provided around the orifice 34 and connects the by-pass conduit 31 and the chamber 29. A seat 35 is formed around the orifice 28. The valve 32 is controlled by the float 19 and the valve 22, there being provided a lost motion connection between the valves 22 and 32 in order that slight variations in the level of liquid fuel in the float chamber 18 causing operation of the valve 22 would not affect firm seating of the valve 32 in the seat 33. In the present embodiment of the invention the lost motion connection between the valves 22 and 32 comprises a valve stem 36 secured to the valve 32 and extending into the hole 37 in the valve 32. A transverse pin 38 arranged in the extension 23 of the valve 22 transversely thereof passes through a slot 39 provided in the lower end of the stem 36. By virtue of such a construction, a certain amount of movement of the valve 32 is permitted without unseating the valve 32. A spring 40 is provided to press the valve 32 upward and close the orifice 34 except when the valve is unseated by the action of the float as above described. A flanged disk or washer 41 made of highly buoyant material, such as cork, is provided on the valve 22 in order to increase the buoyancy thereof and to adapt the valve 22 to rise in the chamber 29 for closing the orifice 34 when the chamber 29 is filled with liquid fuel.

From the foregoing, it can be understood that when the liquid fuel in the suction conduit 15 becomes vaporized, the fuel pump 14 will pump such vapor. When all of the liquid fuel from the delivery conduit 30 is passed into the float chamber 29, the entire conduit 30 and the chamber 29 are filled with fuel vapor. In the prior structures continued operation of the engine under such conditions results in consuming the liquid fuel from the float chamber and retardation and stalling of the engine.

In the present structure the valve 32 is opened and the vapor is by-passed directly to the manifold. Since the suction capacity of the entire engine is thus available, the vapor in the conduits and the carburetor is soon withdrawn and a flow of liquid fuel is reestablished. This is accomplished before the liquid fuel contained in the float chamber is entirely consumed or falls below a certain predetermined minimum level where engine operation would be adversely affected.

When the delivery conduit 30 and the chamber 29

29 are filled with liquid fuel, the suction of the engine acting on the valve 32 through the conduit 31, the pressure of the spring 40 and the buoyancy of the valve 32 are sufficient to press the valve 32 against the seat 33 closing tightly the orifice 34. This condition prevails as long as the chamber 29 is filled with liquid fuel. However, as soon as the valve chamber 29 is filled with the fuel vapor the continued consumption of the remaining liquid fuel from the float chamber brings the float 19 into a position where it pulls the valve 22 down far enough to cause the pin 38 to come to the end of the slot 39 and pulls on the valve stem 36. This causes the valve 32 to be unseated and its weight together with the discontinuation of the action of the engine suction thereon causes the valve 32 to descend on the seat 35 and to close the orifice 28 connecting the valve chamber 29 and the float chamber 18.

When such a condition occurs, the entire suction of the engine is caused to act through the conduits 31 and 30 on the fuel pump. This is sufficient to draw the fuel from the suction conduit 15 and the delivery conduit 30 into the valve chamber 29. It should be noted that the engine suction increases the vacuum in the suction conduit 15 and rapidly reestablishes the continuity of liquid fuel in the system, since by withdrawing large volumes of fuel vapor, the suction action of the engine produces a free expansion of the vapors entrapped in the conduit and this rapid expansion causes a rapid cooling of the liquid fuel in the conduit 15. As soon as the liquid fuel fills the conduits 15 and 30 and the valve chamber 29, the valve 32 rises and by contacting its seat 33 it interrupts the direct communication which has been established between the engine manifold 11 and the delivery conduit 30. The valve 22 being open, the liquid fuel passes into the float chamber 18 rapidly filling the same and reestablishing the normal operation of the carburetor.

An important advantage of the present invention is found in the fact that it not only prevents formation of the vapor lock condition in the engine fuel feed system but permits quick starting of the engine whenever the carburetor bowl is emptied of liquid fuel. This is of particular value in instances where the supply of fuel has become exhausted and the tank and conduits are dry at the time of refilling. In such instances, the time required to empty the line of air by action of the fuel pump alone is greatly reduced. In extreme cold conditions, water vapor in the conduit or the carburetor may form a slush which is not readily removed by the fuel pump alone. The added suction made available by the present invention will also be found helpful in clearing the line of such obstructions.

I claim:

1. In an internal combustion engine having an intake manifold, a fuel supply reservoir, a carburetor including a float chamber, a float in said chamber and a valve operated thereby, a fuel pump, a suction conduit connecting the suction side of said pump with said reservoir and a delivery conduit connecting the delivery side of the pump with the float chamber for delivering the fuel therinto, said valve adapted to interrupt said delivery conduit when the fuel in the float chamber rises above a predetermined level, a by-pass conduit connecting said delivery conduit with the engine manifold; and valve means actuated by said float and adapted to provide a direct communication between said delivery and said by-

pass conduits when the liquid fuel in said chamber falls below a predetermined level and interrupting at the same time the communication between the delivery conduit and the float chamber.

2. In an internal combustion engine having an intake manifold, a fuel supply reservoir, a carburetor including a float chamber, a float in said chamber and a valve operated thereby, a fuel pump, a suction conduit connecting the suction side of said pump with said reservoir and a delivery conduit connecting the delivery side of the pump with the float chamber for delivering the fuel therinto, said valve adapted to interrupt said delivery conduit when the fuel in the float chamber rises above a predetermined level, a by-pass conduit connecting said delivery conduit with the engine manifold; valve means actuated by said float chamber valve and adapted, when the fuel in the float chamber is below a predetermined level, to provide a direct communication between said delivery and said by-pass conduits interrupting at the same time the communication between the delivery conduit and the float chamber.

3. In an internal combustion engine having an intake manifold, a fuel supply reservoir, a carburetor including a float chamber, a float in said chamber and a valve operated thereby, a fuel pump, a suction conduit connecting the suction side of said pump with said reservoir and a delivery conduit connecting the delivery side of the pump with the float chamber for delivering the fuel therinto, said valve adapted to interrupt said delivery conduit when the fuel in the float chamber rises above a predetermined level, a by-pass conduit connecting said delivery conduit with the engine manifold; valve means actuated by said float chamber valve and adapted, when the fuel in the float chamber is below a predetermined level, to provide a direct communication between said delivery and said by-pass conduits interrupting at the same time the communication between the delivery conduit and the float chamber, said valve means being connected to said float chamber valve by means of a lost motion device, whereby a desired amount of fluctuation of the float is permitted without affecting said valve means.

4. In an internal combustion engine having an intake manifold, a fuel supply reservoir, a carburetor including a float chamber, a float in said chamber and a valve operated thereby, a fuel pump, a suction conduit connecting the suction side of said pump with said reservoir and a delivery conduit connecting the delivery side of the pump with the float chamber for delivering the fuel therinto, said valve adapted to interrupt said delivery conduit when the fuel in the float chamber rises above a predetermined level, a by-pass conduit connecting said delivery conduit with the engine manifold; valve means actuated by said float chamber valve and adapted, when the fuel in the float chamber is below a predetermined level, to provide a direct communication between said delivery and said by-pass conduits interrupting at the same time the communication between the delivery conduit and the float chamber.

5. In a liquid fuel feed system for an internal combustion engine having an intake manifold, a carburetor including a float chamber with a float operatively arranged therein, a fuel reservoir, a fuel pump, a suction conduit connecting the suction side of said pump with said reservoir, a valve chamber arranged on said car-

buretor and communicating with said float chamber, a delivery conduit operatively connecting the delivery side of said pump with said valve chamber, a by-pass conduit operatively connecting said valve chamber with the engine manifold, a float chamber valve controlling the orifice provided between the float chamber and the valve chamber, and a vapor lock control valve arranged in said valve chamber and actuated by said float chamber valve with the aid of a lost motion connection, said vapor lock control valve being adapted to keep the communication between said by-pass conduit and said valve chamber interrupted when the fuel in the float chamber stands above a predetermined level, said valve being further adapted to establish a communication between the valve chamber and the by-pass conduit when the fuel in the float chamber falls below said predetermined level.

6. In a liquid fuel feed system for an internal combustion engine having an intake manifold, a carburetor including a float chamber with a float operatively arranged therein, a fuel reservoir, a fuel pump, a suction conduit connecting

the suction side of said pump with said reservoir, a valve chamber arranged on said carburetor and communicating with said float chamber, a delivery conduit operatively connecting the delivery side of said pump with said valve chamber, a by-pass conduit operatively connecting said valve chamber with the engine manifold, a float chamber valve controlling the orifice provided between the float chamber and the valve chamber, and a vapor lock control valve arranged in said valve chamber and actuated by said float chamber valve with the aid of a lost motion connection, said vapor lock control valve being adapted to keep the communication between said by-pass conduit and said valve chamber interrupted when the fuel in the float chamber stands above a predetermined level, said valve being further adapted to establish a communication between the valve chamber and the by-pass conduit when the fuel in the float chamber falls below said predetermined level closing at the same time the orifice between the valve chamber and float chamber.

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