

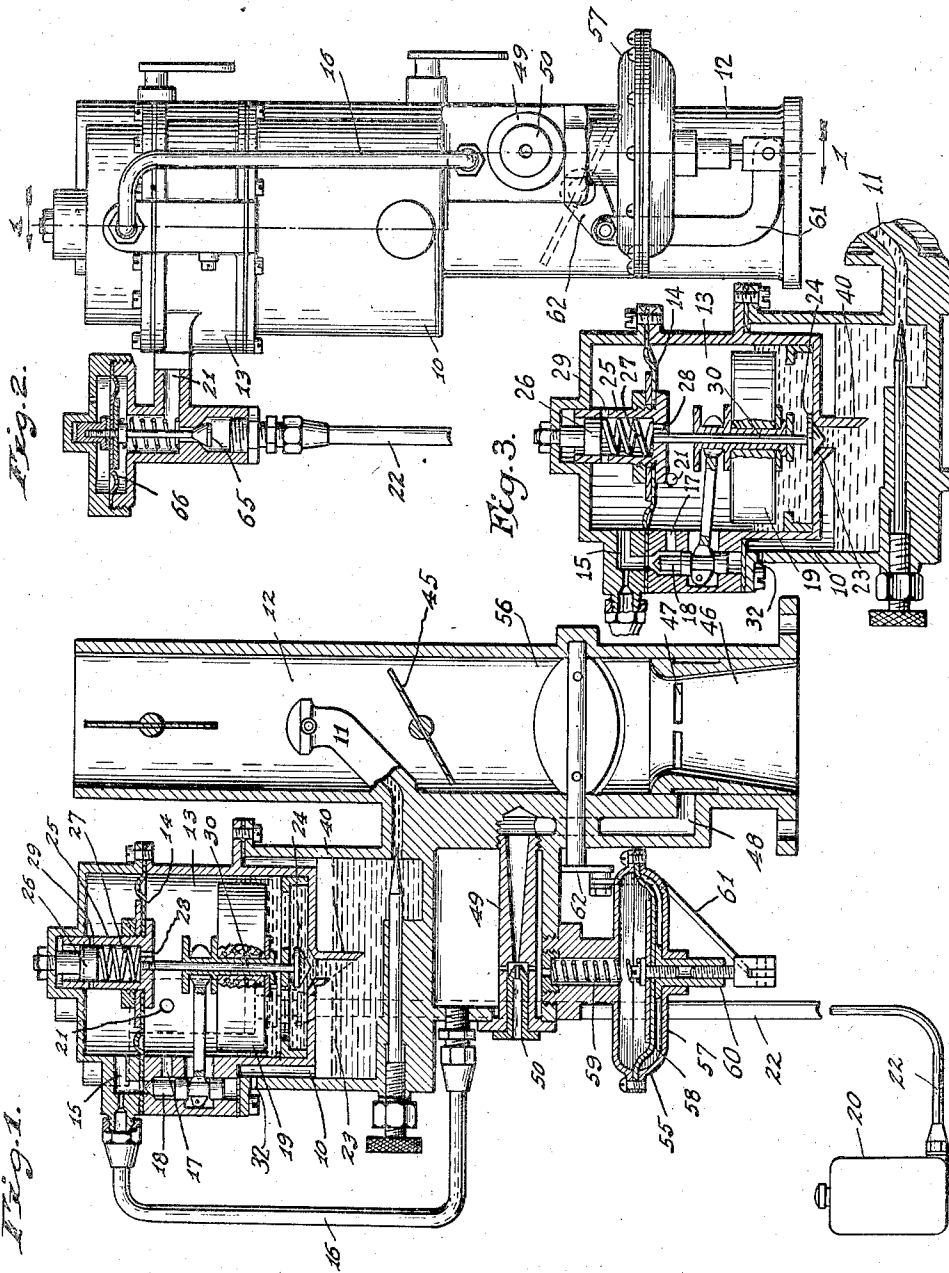
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FUEL LIFT CARBURETOR

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FUEL LIFT CARBURETOR

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My invention relates primarily to fuel-feed systems for internal combustion engines using liquid fuel and has for its object the provision of a fuel-feed system which will elevate fuel from a supply tank to the point of delivery and which will be simple in construction and positive in operation. Another object of my invention is to produce a fuel-feed system which can readily be embodied in association with a carburetor of any desired type. A further object of my invention is to provide a suction-operated fuel-feed system of an automobile with means for preventing flooding should the automobile ever assume a position in which fuel would tend to flow by gravity from the supply tank.

Still another object of my invention is to provide for a suction-operated fuel-feed system, or for any other suction-operated device, means which will insure the existence of a minimum pressure-differential under varying conditions of engine operation.

The accompanying drawings illustrate my invention: Fig. 1 is a somewhat diagrammatic view of a carburetor and associated fuel-feeding system, largely in section on the line 1—1 of Fig. 2; Fig. 2 is a side elevation of the device illustrated in Fig. 1 with parts thereof broken away to illustrate the interior construction more clearly; and Fig. 3 is a fragmental view similar to Fig. 1 but showing the movable parts of the device in different positions.

The carburetor shown in the drawings embodies a fuel reservoir 10 which, in that fuel supplied at regulated rate from it passes through a jet 11 to the mixture intake conduit 12 of the engine, is the equivalent of the float-bowl in the conventional carburetor; but the reservoir 10 differs from the conventional float-bowl in that it embodies no float. Associated with the reservoir 10, and conveniently disposed therein, is a fuel-feeding chamber 13 divided horizontally by a flexible diaphragm 14. That part of the chamber 13 lying above the diaphragm 14 communicates through a port 15 with a conduit 16 by means of which it is subjected to subatmospheric pressure as the result, either directly or indirectly, of the partial vacuum existing within the intake manifold of the engine when it is operated.

That portion of the chamber 13 lying below the diaphragm 14 also communicates, through a port 17, with the conduit 16; but associated with the port 17 there is a valve 18 controlled by a float 19 in the chamber and so arranged as to be

closed when the fuel-level in the chamber 13 is at or above a predetermined point.

Fuel is supplied to the chamber 13 through a port 21 communicating with the fuel-supply line 22 leading from a supply tank 20 which normally is at a lower level than the chamber 13. The bottom of the chamber 13 is provided with a fuel-discharge opening 23 by means of which the fuel in the chamber may flow into the reservoir 10; and associated with the opening 23 is a valve member 24 connected to move with the diaphragm 14.

Also movable with the diaphragm 14, and conveniently mounted directly upon it, is an upwardly opening cup-shaped member 25 which receives a stationary piston 26 and a spring 27, the latter acting between the piston 26 and the bottom of the cup to exert a downward force on the diaphragm 14. A small port 28 extending through the bottom of the cup 25 provides communication between the interior thereof and that portion of the chamber 13 lying beneath the diaphragm. In the annular wall of the cup 25 there of are one or more ports 29 which provide communication between the interior of the cup and that portion of the chamber 13 lying above the diaphragm, the ports 29 being so located that in upward and downward movement of the cup and diaphragm they are alternately covered and uncovered by the piston 26.

Conveniently, the upper end of the chamber 13 is so formed as to receive the upper end of the cup 25 and to serve as a guide therefor. The valve 24 may be connected to the diaphragm 14 by a valve stem 30 the upper end of which is screw-threaded into the bottom of the cup 25. This valve stem 30 may conveniently serve as a guide for the float 19.

Except for the air-discharge ports 15 and 17, and the fuel inlet and discharge openings 21 and 23, the chamber 13 is sealed. The fuel-reservoir 10, however, is open to atmosphere as through a port 32 near the top thereof.

The parts of the device are illustrated in Fig. 1 of the drawings in the positions they respectively occupy when the fuel contained in the chamber 13 is being discharged into the reservoir 10 and is not being augmented by any fuel supplied through the port 21. Under such conditions, the valve 18 is closed by the float 19 and the diaphragm 14, under the influence of intake-manifold vacuum available through the conduit 16, is elevated to maintain the valve 24 open and the ports 29 closed. Under these circumstances, the fuel-level in the reservoir 10 remains approx-

imately constant at an elevation just sufficient to prevent air flow from the reservoir 10 to the chamber 13, for fuel can not escape from the chamber 13 except as air enters the opening 23 to permit its displacement. As fuel is used from the reservoir 10, the opening 23 is uncovered, and air enters the chamber 13 through the opening 23 to permit fuel to run into the reservoir 10.

When the fuel level in the chamber 13 drops to the point where the valve 18 opens, as indicated in Fig. 3, the sub-atmospheric pressure of the intake-manifold is applied through the tube 16 to the chamber 13 below the diaphragm 14 to counteract the effect on the diaphragm 14 of the sub-atmospheric pressure existing thereabove. As the result of this counteracting effect and of the force exerted by the spring 27, the diaphragm is forced downwardly to close the valve 24 and to prevent any further discharge of fuel through the opening 23. Because of the sub-atmospheric pressure now existing in the chamber 13 as the result of the opening of the valve 18 fuel from the tank 20 is drawn thereinto through the pipe 22 and port 21. The tank 20, of course, is vented. As fuel enters the chamber 13 the fuel-level therein rises and the float 19 eventually closes the valve 18. This action, however, does not stop the supply of fuel to the chamber 13, as the space therein below the diaphragm 14 is still subjected to subatmospheric pressure applied through the ports 28 and 29.

When the surface of the fuel in the chamber 13 reaches the lower end of the port 28, further egress of air therethrough is prevented, and a differential pressure tending to elevate the diaphragm is created. Two factors contribute to the creation of such a differential pressure. In the first place, the liquid fuel cannot enter the port 28 with the same facility as did air; and, in the second place, any liquid fuel which does enter the port and the cup 25 builds up a liquid column rising above the level of the fuel below the diaphragm and creating a hydrostatic pressure which, transmitted to the lower surface of the diaphragm, tends to move it upwardly. As the result of these factors, the diaphragm 14 is raised to open the valve 24 and close the ports 29, as shown in Fig. 1. The closing of the ports 29 prevents the imposition of sub-atmospheric pressure upon the fuel in the chamber 13 even when the fuel-level therein drops; and fuel is therefore free to escape from the chamber 13 into the reservoir 10 as air enters the opening 23.

I have found it desirable to associate with the opening 23 a downwardly extending tube 40, the lower end of which is cut off obliquely at a relatively sharp angle. In the absence of such or an equivalent arrangement I find that the opening 23 must be made inordinately large; as otherwise the surface tension of the liquid fuel may prevent it from running out of the chamber 13 even when the level in the reservoir 10 drops below the bottom of the chamber.

During the interval in which the valve 24 is closed, the fuel level in the reservoir 10 will drop as fuel is discharged into the mixture conduit, and will continue to drop until the chamber 13 becomes filled with fuel. In practice, I have found no difficulty in so proportioning the device that the chamber 13 will refill before the fuel level in the reservoir 10 has dropped sufficiently to effect any material change in the mixture proportions.

In the ordinary operation of an automobile engine conditions frequently arise, especially at

low speed and open throttle, when the intake manifold vacuum is insufficient to be depended upon to elevate the fuel into the chamber 13. I therefore prefer to employ some type of booster arrangement by which the effect of intake-manifold vacuum in creating sub-atmospheric pressure in the chamber 13 may be augmented. To this end, I may dispose between the carburetor-throttle 45 and the engine a venturi 46 the throat of which communicates through ports 47 with an air-inlet passage 48 supplied with air through the venturi 49 of an aspirator 50. The throat of this aspirator communicates with the tube 16; and, as the static pressure at the throat of the aspirator venturi 49 will be lower than that at the throat of the venturi 46, which latter pressure will in turn be lower than that existing in the intake manifold beyond the venturi 46, the pressure applied through the tube 16 to either the upper or both compartments of the chamber 13 will be materially lower than that existing in the intake manifold. With this arrangement, fuel can be elevated through a considerably greater distance than if the unaided intake-manifold vacuum were employed.

Even when the booster effect of such a device as the aspirator 50 is utilized, there still may be occasions when the intake-manifold vacuum is insufficient to elevate fuel into the chamber 13. To prevent this condition from interfering with the satisfactory operation of my device I may include therein mechanism which will insure that a predetermined minimum vacuum will exist in the intake-manifold. As indicated in the drawings, this mechanism takes the form of a pressure-responsive element 55 which controls the position of an auxiliary throttle valve 56 disposed in the intake conduit of the engine between the throttle 45 and the venturi 46, the arrangement being such that a decreased vacuum in the intake-manifold will result in a partial closing of the auxiliary throttle 56.

Preferably, the pressure-responsive element 55 is responsive, not directly to the pressure in the intake manifold, but instead to the pressure at the throat of the aspirator-venturi 49. As the vacuum at the throat of the aspirator 49 is usually several times as great as the vacuum in the intake-manifold, I am thus enabled to use a less sensitive pressure-responsive mechanism in the element 55.

As indicated in the drawings, the pressure-responsive element 55 includes a casing 57 within which is mounted a diaphragm 58 dividing the interior of the casing into two compartments, the upper one of which communicates with the throat of the venturi 49 and the lower of which communicates with the atmosphere. A spring 59 tends to force downwardly the diaphragm 58 and a slidable member 60 which is rigid therewith and which projects outwardly through the lower wall of the casing 57. The lower end of the sliding member 60 is connected, as by means of a link 61, with an arm 62 on the shaft of the auxiliary throttle 56.

Any drop in intake-manifold vacuum will be reflected as an increased pressure at the throat of the venturi 49; and this increased pressure, aided by the spring 59, will force downwardly the diaphragm 58 and member 60 to move the auxiliary throttle valve 56 toward closed position. This movement of the throttle valve will impose a restriction upon the gases flowing through the intake conduit and will thus create a pressure-drop (or an increase in vacuum) in

the intake-manifold. When the vacuum in the intake-manifold is above the predetermined minimum, the resultant reduced pressure at the throat of the venturi 49 will be transmitted to the upper compartment on the casing 57 with the result that the diaphragm and slidable member 60 will be raised and the valve 56 moved toward open position so as to reduce the resistance it offers to the flow of mixture through the intake conduit.

The auxiliary throttle 56 with its operating mechanism has an advantage in addition to its function of maintaining a minimum intake-manifold vacuum as such. When an internal combustion engine is operating at low speeds and fully open throttle the velocity of flow at all points along the intake conduit is not infrequently so low that poor atomization of the liquid fuel is obtained. As a result, the engine may deliver less power than if the throttle were partially closed or the intake-conduit otherwise restricted to produce a localized increase in the velocity of mixture-flow. My auxiliary throttle 56 operates automatically to produce such a localized increase in mixture velocity; for the drop in intake-manifold vacuum which occurs at low speeds and open throttle causes the pressure-responsive element 55 to move the auxiliary throttle 56 toward closed position and increase the velocity of the mixture flowing past it.

With my invention embodied in an automobile conditions may arise, as when the automobile with its gasoline tank in the rear and engine in front is headed down a steep slope, under which the chamber 13 may be lower than the fuel tank. In these circumstances, fuel would tend to flow by gravity from the fuel tank into the chamber 13. To prevent this, I may place in the fuel-supply line 22 a valve 65 controlled by a pressure-responsive element 66 responsive to the pressure in the chamber 13 and adapted to close the valve 65 whenever the pressure in the chamber 13 becomes substantially atmospheric. So long as the chamber 13 is not full, fuel can of course flow therein without producing any harmful result; and as soon as the chamber 13 becomes full, its connection with the throat of the venturi 49 (or with the intake-manifold) is broken to destroy the partial vacuum which previously existed. When this occurs, the pressure-responsive element 66 closes the valve 65 and prevents fuel from running into the chamber 13 even if the fuel-supply tank is above the level of the chamber 13.

I claim as my invention:

1. In a fuel feed apparatus, a fuel reservoir, a fuel feed chamber disposed above said reservoir and discharging therein, a valve controlling communication between said chamber and reservoir, a horizontal flexible diaphragm dividing said chamber into upper and lower compartments and operatively connected to said valve, said diaphragm being biased downwardly, an air-exhausting means connected to said two compartments, a second valve responsive to fuel-level in said chamber and controlling the connection between said air-exhausting means and said lower compartment, a fuel tank below said chamber and connected to the lower compartment thereof, said fuel tank being open to atmosphere, means providing a passage between said upper and lower compartments, said passage being restricted to an extent such that upward fuel-flow through it under the influence of said exhausting means cannot occur without the existence of

a differential pressure sufficient to raise said diaphragm, and provisions for preventing flow through said passage when said diaphragm is raised.

2. In a fuel-feed system, a fuel-feed chamber, a horizontal flexible diaphragm dividing said chamber into upper and lower compartments and biased downwardly, a fuel-supply tank connected to said lower compartment, said fuel tank being open to atmosphere, means for exhausting said upper compartment, means providing a passage between said upper and lower compartments, a valve in said passage and operatively associated with said diaphragm to be closed by upward movement thereof, said passage being restricted to an extent such that upward fuel-flow through it under the influence of said exhausting means cannot occur without the existence of a differential pressure sufficient to raise said diaphragm and close said valve, an outlet near the bottom of said lower compartment, and an outlet valve controlling said outlet, said outlet valve being operatively connected to said diaphragm to be opened when the diaphragm is raised.

3. In a fuel-feed system, a fuel-feed chamber, a fuel-supply tank open to atmosphere and connected to said fuel-feed chamber, an air chamber adapted for connection to air-exhausting means, means providing a passage connecting said two chambers and communicating with said fuel-feed chamber at a point slightly below the maximum fuel level therein whereby fuel will enter the passage as such maximum fuel level is approached, a valve in said passage, a pressure-responsive element responsive to the differential in fluid pressures at opposite ends of said passage and operatively associated with said valve, said fuel-feed chamber being provided with an outlet port near its bottom, an outlet valve controlling said outlet port and operatively connected to said pressure-responsive element to be closed thereby in response to the effect of differential pressures thereon, said passage being restricted to an extent such that fuel-flow through it cannot occur without the creation of a pressure-differential sufficient to cause said pressure-responsive element to close said first named valve.

4. In a fuel-feed system, a fuel-feed chamber, a fuel-supply tank open to atmosphere and connected to said fuel-feed chamber, an air chamber adapted for connection to air-exhausting means, means providing a passage connecting said two chambers, a valve in said passage, said fuel-feed chamber being provided with an outlet port near its bottom, an outlet valve controlling said port, and means operative when the fuel-level in said chamber reaches a predetermined maximum for closing said first named valve and opening said outlet valve, said means including a pressure-responsive element responsive to the differential in fluid pressures at opposite ends of said passage and operating both said valves.

5. In a fuel-feed system, a fuel-feed chamber, a horizontal flexible diaphragm dividing said chamber into upper and lower compartments, a fuel-supply tank below said chamber and connected to the lower compartment thereof, means for exhausting said upper compartment, means providing a restricted passage between said upper and lower compartments, said diaphragm being biased downwardly with a force greater than the resultant of the total fluid pressures on opposite sides of said diaphragm when air is flowing upwardly through said passage under the influence of said exhausting means and less than such re-

sultant when liquid fuel is flowing upwardly through said passage under the influence of said exhausting means, said lower compartment being provided with an outlet near its bottom, an outlet valve controlling said outlet, and a second valve controlling flow through said restricted passage, said diaphragm being operatively connected to said valves to close the latter and open the former when the diaphragm moves upwardly as the result of the entry of liquid fuel into said passage.

6. In a fuel-feed system for an internal combustion engine having an intake passage, a fuel-feed chamber, a fuel-supply tank disposed below said chamber and connected thereto, a fuel-supply conduit for conveying fuel from said supply tank to said chamber, said chamber being provided with an outlet near its bottom, a valve controlling said outlet, yieldable means for closing said valve and thereby preventing egress of fuel through said outlet and means for intermittently connecting said fuel chamber to said intake passage to exhaust said chamber and induce fuel-flow from said supply tank to said chamber, said means including a pressure-responsive element responsive at all times to fluid pressure in said passage and operative upon the conclusion of each period of chamber-exhaustion to open said valve against the influence of said yieldable means and to maintain it open until the chamber is substantially empty of fuel or until the pressure in said passage reaches a predetermined maximum.

7. In a fuel-feed system, a fuel reservoir, a fuel-feed chamber disposed above said reservoir and having near its bottom an outlet port through which fuel may pass to said reservoir, a fuel supply tank, a conduit interconnecting said supply tank and said fuel-feed chamber, means for intermittently exhausting said fuel-feed chamber to induce fuel flow thereinto through said conduit, an outlet valve controlling said outlet port, mechanism for automatically closing said valve during periods in which said fuel-feed chamber is being exhausted and for opening said valve during the intervals between such exhaustion periods, said outlet port constituting the sole passage for the admission of air to said fuel-feed chamber whereby to provide a barometric feed of fuel from said chamber into said reservoir, a valve in said conduit, and means responsive to fluid pressure in said fuel-feed chamber for maintaining said last named valve closed when the fluid pressure in said chamber is above a predetermined value and open when such pressure is below that predetermined value.

8. In a fuel-feed system, a fuel reservoir, a fuel-feed chamber disposed above said reservoir and having near its bottom an outlet port through which fuel may pass to said reservoir, a fuel supply tank, a conduit interconnecting said supply tank and said fuel-feed chamber, means for intermittently exhausting said fuel-feed chamber to induce fuel flow thereinto through said conduit, an outlet valve controlling said outlet port, mechanism for automatically closing said valve during periods in which said fuel-feed chamber is being exhausted and for opening said valve during the intervals between such exhaustion periods, said outlet port constituting the sole passage for the admission of air to said fuel-feed chamber whereby to provide a barometric feed

of fuel from said chamber into said reservoir, a valve in said conduit, and means for automatically opening said last named valve when said outlet valve is closed and for closing said last named valve when said outlet valve is open.

9. In a fuel-feed system, a fuel-feed chamber, a fuel supply tank disposed below said fuel-feed chamber, a fuel-supply conduit interconnecting said fuel-feed chamber and supply tank, said fuel-feed chamber having an outlet port near its bottom, an outlet valve controlling fuel flow through said port, an air chamber, means providing a passage between said two chambers, said passage communicating with said fuel-feed chamber at a point adjacent but below the maximum fuel level therein, a second valve in said passage, air-exhausting means connected to said two chambers, means responsive to the differential in fluid pressures at the respective ends of said passage and operatively connected to said outlet valve and said second valve, said passage being restricted to an extent such that fuel flow through it from said fuel-feed chamber into said air chamber cannot occur without the existence of a pressure-differential sufficient to cause said pressure-responsive element to close said second valve, a third valve controlling the connection of said air-exhausting means to said fuel chamber independently of said second valve, means responsive to fuel-level in said fuel-feed chamber for opening said third valve whenever the fuel level in said fuel-feed chamber reaches a predetermined minimum, a fourth valve in said fuel-supply conduit, and means responsive to fluid-pressure in said fuel-feed chamber for maintaining said fourth valve closed except when the fluid pressure in said fuel-feed chamber is at or below a predetermined maximum.

10. In a fuel-feed apparatus, a fuel-feed chamber, a fuel-supply tank below said chamber and connected thereto, said chamber having a fuel outlet port near its bottom, an outlet valve controlling said port, an air chamber, an air-exhausting means connected to said air chamber, said two chambers being interconnected by a passage through which air may be exhausted from said fuel-feed chamber to induce fuel-flow thereinto from said supply tank, a second valve in said passage, means responsive to the fuel-level in said fuel-feed chamber for automatically closing said second valve when such fuel-level rises to a predetermined maximum, said means including a pressure-responsive element jointly responsive to the respective fluid-pressures in said two chambers and operating to close said second valve whenever the fluid pressure in said air chamber is below that in said fuel-feed chamber and to open said second valve when the fluid pressures in said two chambers are substantially the same, and a second means responsive to fuel-level in said fuel-feed chamber and operating when such fuel-level reaches a predetermined minimum to equalize the pressures in said two chambers and thereby cause said pressure-responsive element to open said second valve.

11. The invention set forth in claim 10 with the addition that said outlet valve is operatively connected to said pressure-responsive element to be opened thereby as said second valve is closed and to be closed thereby when said second valve is opened.

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