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Aoyama et al.

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[54] **FUEL FEEDING & CHARGE FORMING APPARATUS**

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[30] **Foreign Application Priority Data**

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[52] **U.S. Cl.** ..... **261/35**, 261/69 A, 261/DIG. 68

[51] **Int. Cl.** **F02m 17/04**

[58] **Field of Search** ..... 261/DIG. 68, 35, 69 A

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Attorney, Agent, or Firm—Stevens, Davis, Miller & Mosher

[57] **ABSTRACT**

A carburetor and fuel feeding arrangement for internal combustion engines which includes a substantially horizontally extending mixing passage with venturi and a fuel chamber located below said passage. A diaphragm constitutes an upper wall of the fuel chamber and is adapted to operate a fuel inlet valve. The diaphragm also forms a lower wall of a chamber which communicates with the atmosphere. A main fuel discharge orifice is positioned substantially on the center line of the diaphragm. A slow fuel passage branches from a fuel passage connecting the fuel chamber and the orifice and communicates with secondary orifices. Means is provided for discharging into the fuel passages the vapor generated when the apparatus is tilted to extreme positions or inverted. Means between the main fuel passage and the slow fuel passage is provided for preventing the flow of air from the main orifice to the secondary orifices during idling or slow speed motion of an engine.

4 Claims, 7 Drawing Figures

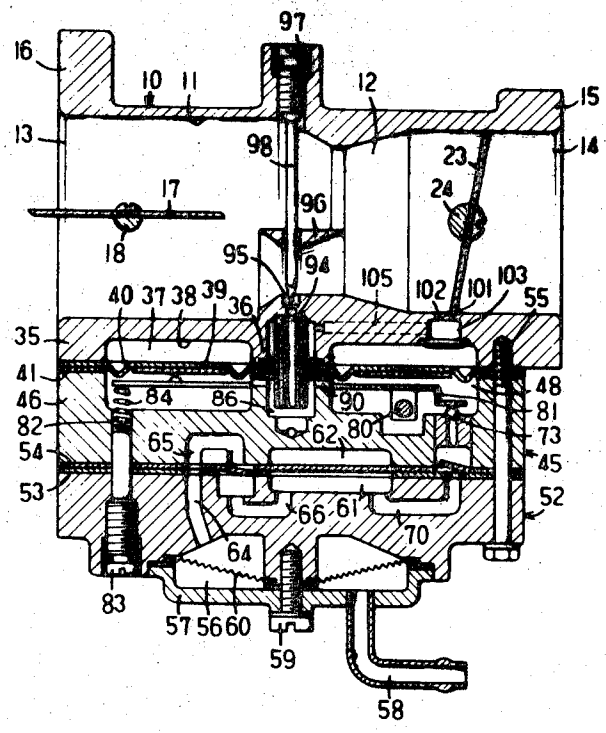


FIG. 1

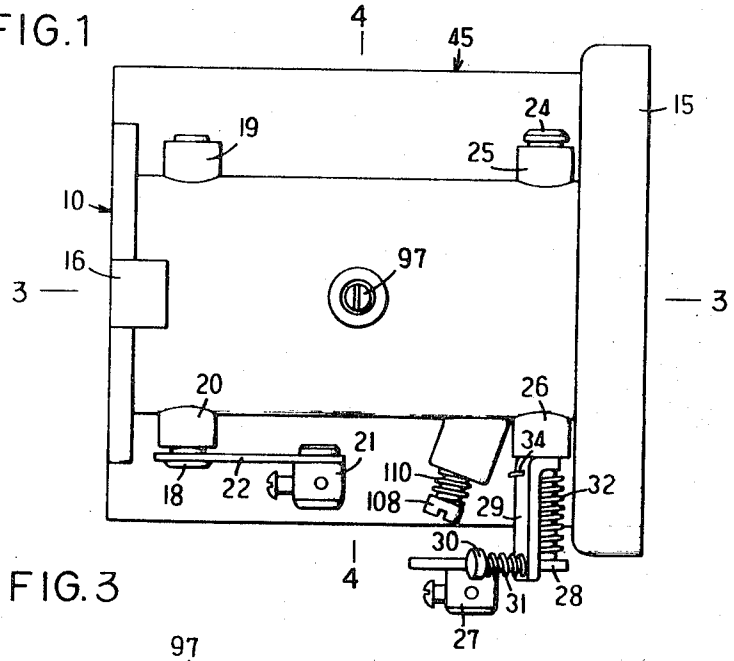


FIG. 3

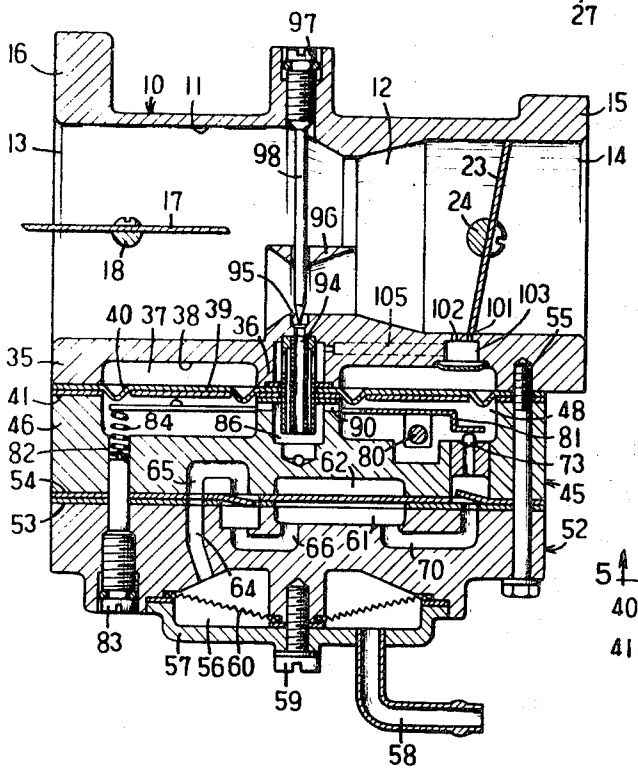


FIG. 2

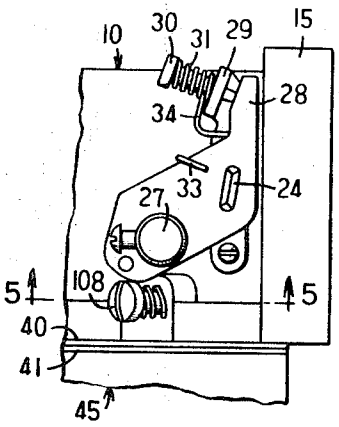


FIG. 4

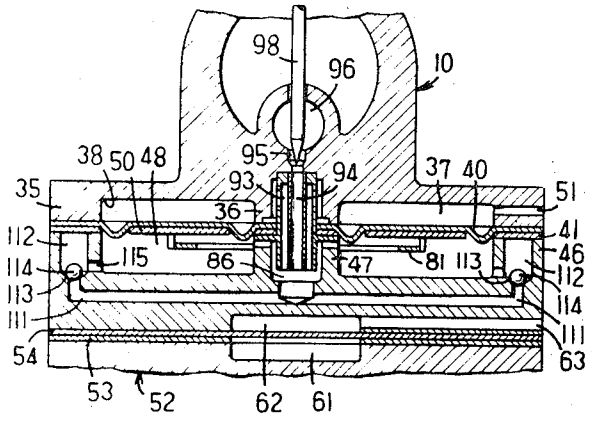


FIG. 5

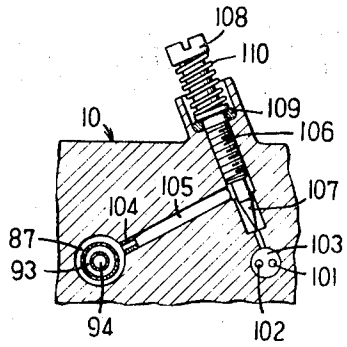


FIG. 6

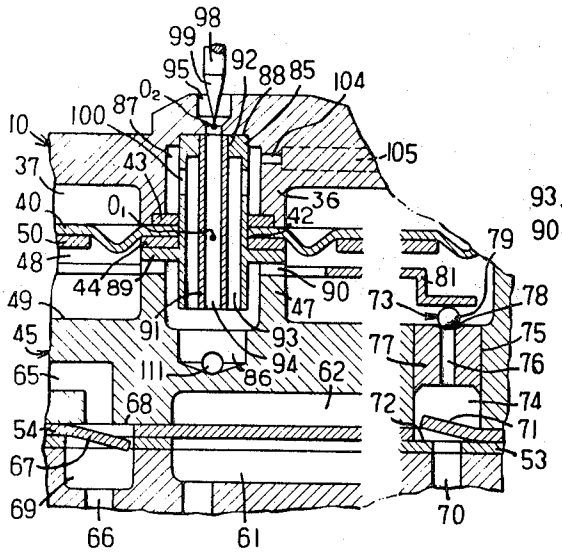
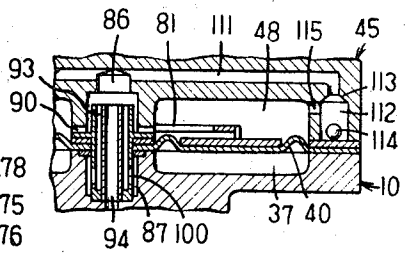


FIG. 7



FUEL FEEDING & CHARGE FORMING APPARATUS

This invention relates to fuel feeding apparatus for internal combustion engines and more particularly to apparatus for supplying a fuel and air mixture to an internal combustion engine in all positions of the engine.

This invention pertains more especially to a diaphragm type carburetor for use with internal combustion engines for motor cars as well as internal combustion engines suitable for powering chain saws, lawn mowers, outboard marine engines and the like which are operated in inverted positions as well as positions of extreme tilt.

Carburetors for use with chain saw engines and the like have a mixing passage, a main fuel nozzle or orifice for delivering fuel for high speed operation into a venturi in the passage and secondary orifices opening into the mixing passage downstream of the venturi for delivering fuel into the mixing passage for engine idling or slow speed operation.

Fuel for the main fuel orifice and the secondary orifices is supplied from a fuel chamber in the carburetor through channel means. One wall of the fuel chamber is defined by a flexible diaphragm which under absorption or reduced pressures in the mixing passage, controls a fuel inlet valve for regulating the flow of fuel from a supply into the fuel chamber. In such arrangement, when the carburetor is in certain positions of tilt or inverted positions, the head of fuel in the fuel chamber is affected by the weight of the diaphragm so that pressure of fuel to be supplied to the orifices will be liable to variation. The variation in pressure of fuel may be theoretically prevented by substantially eliminating the weight of the diaphragm, but practically, this is impossible.

This invention relates to a diaphragm type carburetor or fuel feeding arrangement wherein the fuel chamber is located below the diaphragm.

In the carburetor embodying the present invention, the relation between the main fuel discharge orifice and the diaphragm should be exactly or approximately given by the following formula in order to ensure a supply of the required quantity of fuel from the main fuel orifice irrespective of positions of tilt or angular position of the carburetor;

$$\phi h = W/A$$

wherein

h : the distance between the center of the underside of the diaphragm and the inlet of the main fuel discharge orifice

A : the effective area of the diaphragm

W : the weight of the diaphragm

ϕ : the specific gravity of fuel

Another object of this invention is to provide a diaphragm type carburetor wherein the main fuel orifice opens into the fuel chamber at the center of the diaphragm or at a region close to the center of the diaphragm to ensure a supply of the required quantity of fuel irrespective of carburetor's angular positions. Another object of this invention is to provide a carburetor which discharges into the main fuel passage the vapor of fuel generated by cavitation or percolation into the fuel chamber when the carburetor is tilted or inverted so that the carburetor is free from suffering an insufficience of fuel due to the low level of fuel in the fuel chamber occurring at the time of restoring it to the normal position.

The other object of this invention is to provide a carburetor which prevents flow of air through the fuel passage from the main fuel orifice to the secondary orifices, this flow of air being caused by strong reduced pressure in the mixing passage during idling and slow speed operation of an engine.

Other objects and advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

FIG. 1 is a top plan view of an apparatus embodying the invention;

FIG. 2 is a fragmentary front elevation view of the apratus shown in FIG. 1;

FIG. 3 is a cross sectional view taken substantially along the line 3—3 of FIG. 1;

FIG. 4 is a fragmentary cross sectional view taken substantially along line 4—4 of FIG. 1;

FIG. 5 is a fragmentary cross sectional view taken substantially along line 5—5 of FIG. 2;

FIG. 6 is an enlarged fragmentary view of FIG. 3; and

FIG. 7 is a fragmentary view of FIG. 4, showing the apparatus of this invention in inverted position.

Referring to the drawings, a carburetor body **10** is provided with a horizontally extending mixing passage **11.** This passage **11** includes a venturi **12,** an air inlet region **13** and a mixture outlet region **14.**

The carburetor body **10** is provided at one end with a mounting flange **15** which is adapted to be secured to a boss portion formed on an engine crankcase (not shown) and the air inlet end of the carburetor body **10** is provided with a flange **16** for mounting an aircleaner (not shown).

A choke valve **17** for controlling the admission or air into the air inlet region is disposed in the air inlet region **13** of the mixing passage **11,** and mounted on a choke shaft **18** supported in holes formed in bosses **19** and **20** of the body **10.** Outer portion of the shaft **18** extending outwardly from the body **10** has an arm **22** mounted thereon, the arm having a choke wire terminal **21** for manipulating the choke valve **17.**

Disposed in the mixture outlet region **14** of the mixing passage **11** is a throttle valve **23** mounted on a throttle shaft **24** supported in holes formed in bosses **25** and **26** of the body **10.** Secured to the end of shaft **24** is a L-shaped arm **28** with throttle wire terminal **27** for manipulating the throttle valve **23.** The body **10** is provided with a projection **29** having a threaded opening to receive an adjusting screw **30,** the end of screw **30** being engaged with a portion of the arm **28** to limit the closing movement of the throttle valve **23.** A coil spring **31** surrounds the screw **30** and is compressively held between the head of the screw **30** and the projection **29** in order to retain screw **30** in adjusted position.

A coil spring **32** which surrounds the outwardly extending portion of throttle shaft **24** is engaged at one end with the arm **28** and the other end **34** is engaged with the projection **29,** the coil spring serving to bias the throttle valve **23** toward the closed position as shown in FIG. **3.**

The upper body **10** is formed at its bottom with an angular boss portion **35** and a boss **36** located centrally and an air chamber **37** is defined by the outer and inner

walls of the boss 36 and 35 and communicates through a passage 51 with atmosphere. A flexible member or diaphragm 40 forms a wall 39 of the air chamber 37 opposite to the upper wall of the chamber 37 and extends across the face of the annular boss portion. An annular gasket 41 is disposed on the opposite face of the diaphragm, as shown in FIGS. 3 and 4. The diaphragm 40 is formed at its center with a hole 42.

Diaphragm 40 is held in place by interposing the peripheral region of the diaphragm and the gasket 41 between the boss 35 on the body 10 and an annular boss 46 on a intermediate body 45. The intermediate body 45 is formed with an upwardly extending boss 47 opposite to the boss 36 on the carburetor body 10. An annular spacer 43 is disposed on the top surface of the diaphragm 40 adjacent the hole 42 and held in place between the boss 36 and the center portion of the diaphragm. An annular gasket 44 is disposed on the bottom surface of the diaphragm 40 above the boss 47 on the intermediate body 45.

A fuel chamber 48 is defined by the inner and outer walls of the bosses 46 and 47 on the intermediate body 45 and the diaphragm 40 forms an upper wall of the chamber 48 opposite to the bottom wall 49 of the chamber 48.

Diaphragm 40 has an annular thin disc 50 and vibrates at a high frequency to control the admission of fuel into the fuel chamber 48 for delivery into the mixing passage 11. A diaphragm 54 and a gasket 53 are disposed between the intermediate body 45 and a pump or lower body 52.

Three bodies 10, 45 and 52 are fixed mutually by screws 55 extending through the bodies 45 and 52 to the annular boss portion 35 of the body 10. The lower body 52 is provided with a supplementary fuel chamber 56 which is closed by a closure member 57 provided with a nipple portion 58 adapted to be connected by a pipe or tube member with a fuel supply tank. The closure member 57 is secured to the lower body 52 by means of a screw 59 extending into a threaded bore in a central boss portion which is provided on the body 52.

A filter screen 60 extends across the supplemental fuel chamber 56 to filter fuel admitted from inlet 58 into the chamber 56.

A cavity 61 provided on the top of the lower body 52 forms a fuel chamber in conjunction with the diaphragm 54 and a cavity 62 provided on the underside of the intermediate body 45 forms a pumping or pulse chamber in conjunction with the diaphragm 54. Pumping chamber 62 is in communication with an opening in an engine crankcase through a passage 63.

Fuel filtered through the filter screen 60 is admitted through inlet fuel passages 64, 65 and 66 provided in the lower and intermediate bodies 52 and 45 into the fuel chamber 61. A portion of diaphragm 54 provides an inlet valve flap 67 disposed between the outlet of the passage 65 and the inlet of the passage 66. The bottom surface of the body 45 adjacent the inlet valve flap 67 forms a valve seat 68.

When the diaphragm 54 is moved toward the fuel chamber 62, the valve flap 67 is bent towards the inlet cavity 69 of the passage 66 under the influence of reduced pressure developed in the chamber 61 to move away from the valve seat 68 and connect the passage 65 with the passage 66 whereby fuel flows into the fuel chamber 61.

When the diaphragm 54 is moved towards the fuel chamber 61, the valve flap 67 is seated on the valve seat 68 thereby intercepting communication between the passages 65 and 66; fuel from the chamber 61 is transmitted to an outlet fuel passage 70 of body 52. An outlet valve flap 71 is formed on a portion of the diaphragm 54 adjacent the outlet of the passage 70 and the upper surface of gasket 53 forms a valve seat 72 for the outlet valve flap 71. Valve flap 71 is bendable towards cavity 74 formed at the mouth of a fuel inlet valve 73 belonging to fuel chamber 48 under the influence of the pumping pressure developed in the chamber 61 by the diaphragm 54 thereby connecting the passage 70 with the valve 73. When the diaphragm 54 is moved towards the pumping chamber 62, the valve flap 71 is seated on the valve seat 72 thereby intercepting communication between the passage 70 and the valve 73.

Inlet fuel valve 73 comprises a valve seat member 77 having a fuel passage 76 and fitted in a bore 75 formed in the body 45 and a ball valve element 79 located in the recess 78 on the top surface of the seat member 77 for closing the passage 76. The cavity 74 is defined by a portion of the bore 75 below the seat member 77.

The movement of diaphragm 40 is transmitted to a diaphragm lever 81 fixed on a pivot pin 80. The lever 81 has one end engaging the top of the valve element 79 and forked ends engaging the underside of the diaphragm disc 50.

An adjusting screw 83 is screwed into a threaded opening provided in the lower body 52 and extends into a bore 82 in the intermediate body 45, the bore 82 being in alignment with the threaded opening.

A compressed coil spring 84 is interposed between the top of the screw 83 and the forked ends of the lever 81 to urge the lever 81 towards the diaphragm disc 50.

When the engine is in operation, fuel in the fuel chamber 48 is admitted into the mixing passage 11 under the influence of reduced pressure or aspiration developed in the mixing passage. When pressure in the chamber 48 is reduced, the reduced pressure causes the diaphragm 40 to flex more towards the chamber 48. Movement of the diaphragm towards the chamber 48 causes the lever 81 to be moved around the pivot pin 80 in a counter-clockwise direction as viewed in FIG. 2 against the expansive pressure of the spring 84 whereby the end of the lever 81 moves upwardly, permitting the ball valve element 79 to move away from the valve seat 77 whereby fuel delivered from the fuel chamber 61 by the pumping action of the diaphragm 54 flows through the passages 70 and 76 into the fuel chamber 48.

When fuel pressure in the fuel chamber 48 reaches the predetermined value, the diaphragm 40 is flexed towards the air chamber 37 so that the expansive pressure of the spring 84 causes the lever 81 to seat the valve 79 on the valve seat 78 thereby closing the passage 76 and preventing the flow of fuel into the chamber 48.

The boss 47 of the intermediate body 45 has a recess 86. Disposed in a recess or chamber 87 formed in the boss 36 of the main body 10 is a tubular diaphragm retainer 85 extending through hole 42 of the diaphragm 40 into the recess 86. The retainer 85 is fixed at the upper end in a shallow recess 88 formed at the bottom of recess 87. A flange 89 on the retainer 85 is placed

on the top of the boss 47 and a gasket 44 is disposed between the top of said flange 89 and the diaphragm 40. A spacer 43 is interposed between the boss 36 and the diaphragm 40.

Fuel inflow holes 90 are formed on a portion of the boss 47 adjacent to the flange 89 to allow fuel from the fuel chamber 48 to pass through the recess 86 into the interior of the tubular retainer 85. A separate fuel pipe member 91 defining a main fuel passage 94 extends coaxially to the retainer 85 and is inserted at the upper end into bore 92 on the top of the retainer 85. The pipe member 91 terminates in the lower end of the retainer 85. A secondary annular fuel inlet passage 93 is defined between the retainer 85 and the pipe member 91.

The main fuel passage 94 is in communication with a main fuel discharge orifice 95 formed in the body 10 and opening into a small venturi 96 eccentrically formed in the interior of venturi 12.

A main fuel adjusting screw 97 is threaded into the wall of the body 10 opposite to the orifice 95 and its rod part 98 extends into the venturi 96 across the mixing passage 11 and has at the lower end the needle part 99 inserted into the orifice 95. By adjusting the screw 97, the extent of projection of the needle part 99 into the orifice meters the fuel for delivery through the orifice 95.

Fuel from fuel chamber 48 flows through the hole 90 and recess 86 into the passage 94 and thus the fuel is admitted through the orifice 95 into the venturi 96 under the influence of reduced pressure in venturi 96 and mixed with air intering the inlet region 14 to provide a fuel and air mixture which flows into the crankcase of the engine through the outlet region 13.

Such an arrangement should be exactly or approximately given by the formula

$\phi h = W/A;$

wherein

h is the distance between the center O_1 of diaphragm 40 and the outlet point O_2 of orifice 95,

A is the effective area of the diaphragm 40,

W is the weight of diaphragm 40,

ϕ is the specific gravity of fuel.

Secondary fuel holes or openings 100 are formed on the upper portion of the diaphragm retainer 85 and thus fuel which flows into the passage 93 from the recess 86 is admitted through the holes 100 into the cell 87.

The fuel feeding system for engine idling and slow speed operation comprises a slow speed orifice 102 and an idling orifice 101 opening into the mixing passage 11, as shown in FIGS. 3 and 5.

Holes 101 and 102 are in communication with a supplementary chamber 103 and the annular chamber 87 is in communication with the chamber 103 through secondary fuel passage 105 in which a jet 104 is disposed.

A secondary fuel adjusting screw 106 screwed into the body 10 has at the upper end a needle portion 107 which is inserted into passage 105 for metering fuel flow through the passage 105 into the chamber 103. A coil spring 110 is disposed around the portion of the screw 106 between the head 108 and a sealing ring 109.

When the throttle valve 23 is moved to nearly closed or engine idling position, fuel is delivered into the mixing passage 11 through the idling orifice 101. When the throttle valve 23 is partially opened from engine idling position, the low speed orifice 102 begins to deliver fuel from the supplemental chamber 103 into the mixing passage in addition to the fuel delivered through the engine idling orifice 101.

A vapor release passage 111 extends in parallel to the bottom face 49 of the fuel chamber 48 within the intermediate body 45 and is in communication with the bottom of the recess 86. This passage 111 has at its ends portions 112 extending upwardly within the boss 46 and the upper ends of the passage portions are closed by gasket 41. Valve seats 113 are defined by the bottom walls of the passage portions and cooperate with check ball valves 114 within the passage portions 102. The upwardly extending passage portions 112 are communicated with the fuel chamber 48 by means of vapor release passages 115 which extend laterally from the portions 112 adjacent the valve seats 113.

As seen in FIGS. 2 and 3 of the drawings, when the apparatus is in normal position, the check ball valves 114 are seated on valve seats 113 by its their weight to close the passage 111 so that fuel from chamber 48 can enter recess 86 only through the fuel inflow hole 90. If fuel in the chamber 48 is vaporized due to cavitation and percolation, the vapor enters the chamber 86 through the holes 90 together with fuel and is discharged into the mixing passage 11 through the orifice 95 or orifices 101 and 102.

When the apparatus is in positions of slight tilt the same operation as mentioned above will be obtained. When the apparatus is in positions of extreme tilt or inverted positions, the ball valves 114, as shown in FIG. 7 of the drawings move away from the valve seats 113 until they reach the gasket 41 and thus fuel in the chamber 48 enters the chamber 86 through the holes 100 which are then in the lower position. Meanwhile vapor from fuel in the chamber 48 flows through the passage 115 and passage 111 into the chamber 86 to discharge through orifice 95 or orifices 101, 102 into the mixing passage 11. As a result, fuel in the fuel chamber 48 will maintain a predetermined level which corresponds to the necessary amount of fuel for entering the chamber 86 through the holes 90 just after the apparatus returns to normal position.

The aforementioned formula

$\phi h = W/A$ is always applicable in spite of positions of extreme tilt or inverted positions because h on the left wide and W on the right side concurrently replace each other's positive and negativeness. This formula thus ensures the possibility of controlling fuel pressure in the fuel chamber 48 so that the pressure of fuel at the orifice 95 will be maintained at a constant value. Orifice 95 is positioned on the center axis of diaphragm 40 and thus when the apparatus is moved around the axis of orifice 95, fuel supplied to mixing passage 11 from orifice 95 will not be subjected to centrifugal force thereby ensuring the supply of fuel into mixing passage 11.

The main fuel passage 94 and secondary fuel inlet passage 93 are opened below the fuel level in the chamber 86 to prevent air from flowing from the orifice 95 through passages 94, 93 and 105 into the orifices 101 and 102 during engine idling or slow speed operation. Therefore, air will not thin the mixtures during engine idling or slow speed operation. When the engine goes into high speed operation from idling or slow speed operation, fuel is progressively changed from the flow towards the ports 101 and 102 to the flow towards the

orifice **95** in response to reduced pressure in the venturi **12** or **96.**

We claim:

1. In combination, a fuel feeding apparatus including a body having a mixing passage, an air chamber in said body including an upper wall, a flexible diaphragm forming a lower wall of said air chamber, a fuel chamber in a body including a lower wall and an upper wall formed by said diaphragm, said diaphragm being actuated by aspiration in said mixing passage, a second chamber at the center of said fuel chamber for storing fuel from said chamber, a main fuel discharge orifice and secondary orifices opening into said mixing passage, two passages connecting said second chamber with said orifices, a vapor discharging passage connecting said second chamber with said fuel chamber, a valve means opening the vapor discharging passage only when the apparatus is tilted to extreme positions or inverted, to connect said two chambers.

2. In combination, fuel feeding apparatus including a first body having a mixing passage, an upper air chamber in said first body including an upper wall, a flexible diaphragm forming a lower wall of the air chamber, a lower fuel chamber in a second body including a lower wall and an upper wall formed by said diaphragm, said diaphragm being fixed at its periphery and its center to said two bodies and actuatable by aspiration in said mixing passage, a fuel inlet for said fuel chamber, a fuel inlet valve in said fuel inlet, spring loaded means for opening and closing said valve in response to movement of said diaphragm, a second chamber in the center portion of said second body for storing fuel from the said fuel chamber, a main fuel discharge orifice and secondary orifices opening into the said mixing passage, and two passages connecting the said second chamber with said orifices, said combination further defined by the formula:

$\phi h = W/A$

wherein

h is the distance between the mouth of the said orifice and the center of the underside of said diaphragm,

A is the effective area of said diaphragm,

W is the weight of said diaphragm,

ϕ is the specific gravity of fuel.

3. In combination, a fuel feeding apparatus including a first body having a mixing passage, an upper air chamber in said first body including an upper wall, a flexible diaphragm forming a lower wall of said chamber, a lower fuel chamber in a second body including a lower wall and an upper wall formed by said diaphragm, said diaphragm being fixed at its periphery and its center to said two bodies and actuatable by aspiration in said mixing passage, a fuel inlet for said fuel chamber a fuel inlet valve in said fuel inlet, means operable by said diaphragm, but normally for closing said valve, a second chamber in the center portion of said second body for storing fuel from the top of said fuel chamber, a main fuel discharge orifice and secondary orifices opening into said mixing passage, and two passages connecting the said second chamber with said orifices, said main fuel discharge orifice positioned on the center line of said diaphragm.

4. In combination, a fuel feeding apparatus including a first body having a mixing passage, an upper air chamber in said first body including an upper wall, a flexible diaphragm forming a lower wall of said air chamber, a lower fuel chamber in a second body including a lower wall and an upper wall formed by said diaphragm, said diaphragm being fixed at its periphery and its center to said two bodies and actuatable by aspiration in said mixing passage, a fuel inlet valve in said fuel inlet means operable by movement of said diaphragm, but normally for closing said valve, a second chamber in the center portion of said second body for storing fuel from said chamber, a main fuel discharge orifice and secondary orifices opening into said mixing passage, two passages connecting said second chamber with said orifices, a vapor discharging passage connecting said second chamber with said fuel chamber, and a valve means opening the vapor discharging passage only when the apparatus is tilted to extreme positions or inverted, to connect said two chambers.

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