July 11, 1967 D. L. DONOVAN 3,330,545

CARBURETOR WITH FUEL ENRICHMENT MEANS

Filed Oct. 13, 1965 2 Sheets-Sheet 1

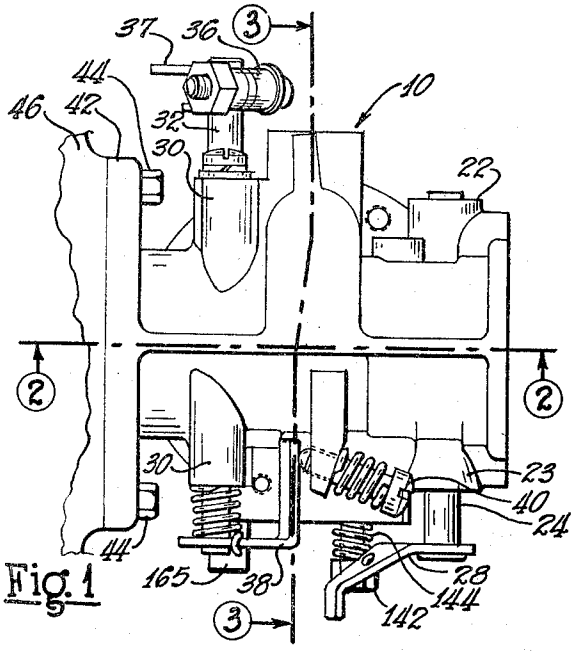


Fig. 1

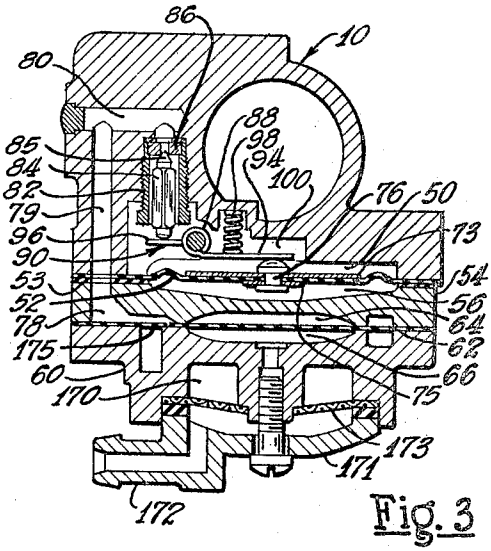


Fig. 3

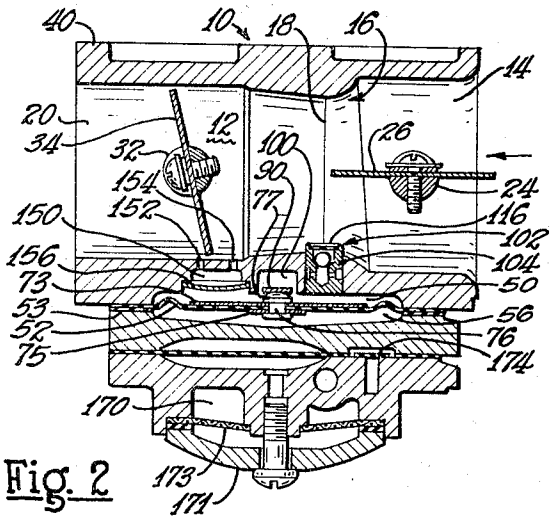


Fig. 2

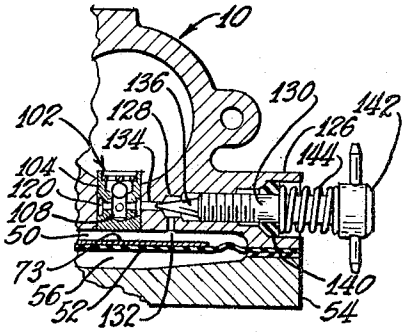


Fig. 8

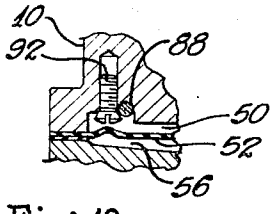


Fig. 10

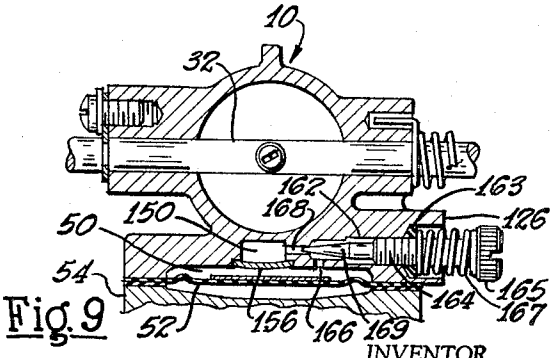


Fig. 9

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CARBURETOR WITH FUEL ENRICHMENT MEANS

Filed Oct. 13, 1965 2 Sheets-Sheet 2

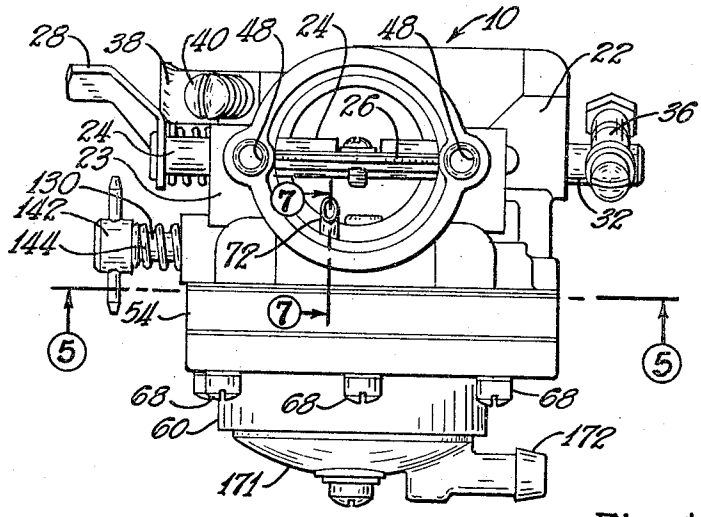


Fig. 4

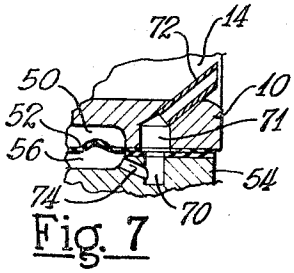


Fig. 7

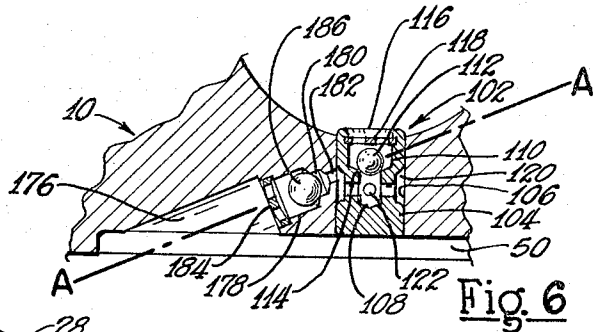


Fig. 6

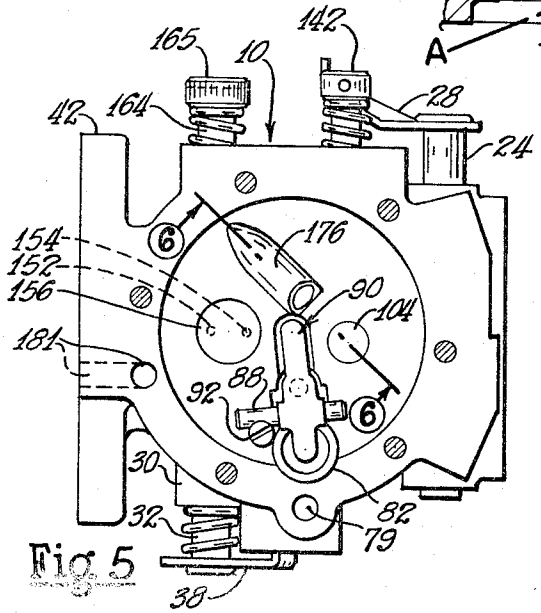


Fig. 5

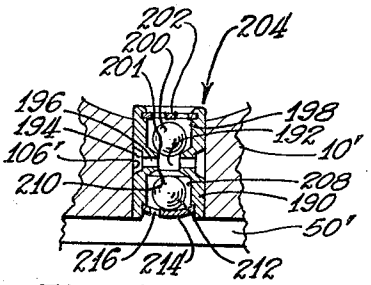


Fig. 11

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3,330,545

CARBURETOR WITH FUEL ENRICHMENT MEANS

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Filed Oct. 13, 1965, Ser. No. 495,537
4 Claims. (Cl. 261—41)

This invention relates to carburetors of a character wherein varying pressures in the fuel and air mixing passage effect delivery of fuel from a fuel chamber into the mixing passage and control a fuel inlet valve to regulate fuel delivery from a supply into the fuel chamber, the fuel being mixed with air in the mixing passage and the mixture conveyed to an internal combustion engine. The invention has particular utility in a carburetor of the diaphragm type and is adapted for use in other types of carbuertor, carburetors embodying the invention being usable with either two cycle or four cycle internal combustion engines and especially those for powering vehicles, marine engines, industrial engines and the like. In a diaphragm-type carburetor wherein varying pressures in the mixing passage influence a diaphragm to control a fuel inlet valve as well as in other types of carburetors, the delivery of fuel from the main nozzle into the mixing passage tends to decrease rapidly as air flow through the mixing passage decreases. This operational characteristic tends to impair the delivery of sufficient fuel for a proper fuel and air mixture at low speeds when the throttle is moved to wide open position, and to retard delivery of fuel from the main nozzle during acceleration.

The invention embraces apparatus for promoting the automatic delivery into the mixing passage of a carburetor of an increased amount of fuel during periods of engine acceleration and at low engine speeds when the throttle valve of the carburetor is in full open or near open position.

Another object of the invention resides in the provision in a carburetor of a valved passage between a main fuel delivery orifice and a fuel chamber for admitting additional fuel to the main orifice under low speed conditions at open throttle and to promote improved acceleration and additionally to interrupt flow of liquid fuel through the passage when the engine is operating at comparatively high speeds or whenever the reduced pressure in the mixing passage is sufficient to cause the valve to close the bypass.

Another object of the invention is the provision in a diaphragm carburetor of a valved bypass between the fuel chamber and the main delivery orifice into the mixing passage wherein the valve is responsive to reduced pressure in the mixing passage to effect a closing of the valve under certain operating conditions.

Another object of the invention resides in the provision in a diaphragm type carburetor of a fuel bypass and pressure responsive valve construction arranged between the fuel chamber and the main fuel delivery orifice whereby slight reduced pressure established in the mixing passage is ineffective to close the valve whereby additional fuel is delivered through the main orifice for enriching the mixture at open throttle low engine speeds under load and to improve acceleration of the engine.

Further objects and advantages are within the scope of this invention such as relate to the arrangement, operation and function of the related elements of the structure, to various details of construction and to combinations of parts, elements per se, and to economies of manufacture and numerous other features as will be apparent from a consideration of the specification and drawing of a form of the invention, which may be preferred, in which:

FIGURE 1 is a top plan view of a charge forming device or carburetor embodying the invention;

FIGURE 2 is a longitudinal sectional view through the carburetor, the view being taken substantially on the line 2—2 of FIGURE 1;

FIGURE 3 is a transverse sectional view taken substantially on the line 3—3 of FIGURE 1;

FIGURE 4 is an end elevational view of the carburetor illustrated in FIGURE 1;

FIGURE 5 is a bottom plan view taken substantially on the line 5—5 of FIGURE 4;

FIGURE 6 is a detail sectional view taken substantially on the line 6—6 of FIGURE 5;

FIGURE 7 is a detail sectional view taken substantially on the line 7—7 of FIGURE 4;

FIGURE 8 is a fragmentary sectional view taken substantially on the line 8—8 of FIGURE 5;

FIGURE 9 is a sectional view taken substantially on the line 9—9 of FIGURE 5;

FIGURE 10 is a fragmentary sectional view taken substantially on the line 10—10 of FIGURE 5, and

FIGURE 11 is a detail sectional view illustrating a modified form of the invention.

While the invention is illustrated and described herein as embodied in a charge forming apparatus or carburetor of the diaphragm type for supplying combustible mixture to internal combustion engines of either the two cycle or four cycle type, it is to be understood that the invention may be embodied in other types of carburetors.

Referring to the drawings in detail and initially to FIGURES 1 through 4, the charge forming apparatus or diaphragm carburetor comprises a body or body member **10** formed of cast metal or other suitable material of a nonporous character which is resistant to deterioration by hydrocarbon fuels. The body **10** is formed with a mixing passage **12** which includes an air inlet region **14**, a Venturi **16**, having a choke band or restriction **18**, and a mixture outlet region **20**.

The body **10** adjacent the air inlet region is formed with bosses **22** and **23** bored to journally support a shaft **24** equipped with a disc valve **26** providing a choke valve arrangement for starting the engine. An arm **28** is secured to the shaft **24** for manipulating the choke valve. The body **10** is provided with bosses **30** bored to journally support a shaft **32** on which is mounted a disc type throttle valve **34** for regulating the flow of fuel and air mixture to an engine with which the carburetor may be used. An exterior portion of the throttle shaft **32** is equipped with means **36** for connecting an operating member **37** with the throttle shaft.

The throttle shaft **32** is provided with an arm **38**, an adjustable abutment screw **40** supported by the body **10** being engageable with the arm **38** for adjusting the engine idling or near closed position of the throttle valve **34**.

The carburetor body has a mounting flange **42** at the outlet end **20** of the mixing passage, the flange having openings accommodating bolts **44** for securing the carburetor to the crankcase **46** of a two cycle engine, or for securing the carburetor to the manifold of an engine of the four cycle type. The body **10** adjacent the air inlet region **14** has threaded openings **48** to receive bolts for securing an air cleaner (not shown) to the body.

The carburetor body **10** is fashioned with a comparatively shallow circular recess providing a fuel chamber **50** adapted to contain liquid fuel. Extending across the fuel chamber **50** and forming a flexible wall thereof is a diaphragm **52** of impervious material, a circular gasket **53** being associated with the diaphragm. A generally circular member or closure plate **54** embraces the exterior major surface of the diaphragm **52**, the member **54** having a recess or clearance space **56** to accommodate flexing movements of the diaphragm **52**.

A fuel pump body **60** is disposed beneath the member **54** with a pumping diaphragm **62** positioned between the

member **54** and pump body **60** providing a pumping or pulse chamber **64** and a fuel chamber **66**, an arrangement hereinafter described. The carburetor body **10** at a region adjacent the periphery of the diaphragm **52** is provided with threaded openings and the members **54**, **60**, the diaphragm **52** and gasket **53** fashioned with aligned openings to receive securing screws **68** for holding these components in assembled relation illustrated in FIGURES 2, 3 and 4.

The diaphragm clearance space or dry chamber **56** in member **54** is vented into the air inlet region **14** of the mixing passage in the manner illustrated in FIGURES 4 and 7. A bore **70** in member **54** is in registration with a bore **71**, the latter being equipped with a vent tube **72** opening into the air inlet region **14**. The space **56** is in communication with the bore **70** by a passage **74**. Thus the air chamber **56** is vented through passage **74**, communicating bores **70** and **71** and vent tube **72** to the air inlet region of the carburetor. The chamber **56** may be vented direct to the atmosphere, if desired.

The diaphragm **52** is reinforced at its central region with disc-like members **73** and **75** disposed at opposite sides of the diaphragm, the discs being held in assembled relation with the diaphragm by a rivet **76** having a head portion **77**. The diaphragm **52** is arranged to regulate or control flow of liquid fuel from the fuel pump or other fuel supply into the shallow fuel chamber **50**. In the arrangement illustrated, connecting fuel flow passages **78**, **79** are provided from the fuel pump construction to an inlet **80** of the carburetor body. Where the fuel pump, or a fuel tank supplying fuel by gravity, is remote from the carburetor, the fuel inlet **80** is connected by a tube with the fuel supply.

The carburetor body **10** is provided with a threaded bore accommodating a fitting or valve cage **82** having a central passage in which is slidably disposed an inlet valve **84** having a cone-shaped valve portion **85**, the valve portion **85** cooperating with a port provided by an annular valve seat **86** disposed in the bore accommodating the valve cage **82** for regulating or controlling fuel flow from the inlet **80** into the fuel chamber **50**.

Pivotally supported or fulcrumed upon a pin **88** is a lever member **90**, the pin being held in place by a threaded member **92** as shown in FIGURES 5 and 10.

The long arm **94** of the lever is adapted to be engaged by the head **77** of the rivet **76** carried by the diaphragm, the short arm **96** of the lever engaging the lower end of the valve body **84**, as shown in FIGURE 3. An expansive coil spring **98** bottomed in a bore provided in the upper wall of the fuel chamber **50** is disposed close to the fulcrum pin **88** and engages the long arm **94** of the lever biasing the lever in a clockwise direction about its fulcrum, as viewed in FIGURE 3, normally urging the inlet valve **85** into seating position with the annular valve seat **86**. The fuel chamber **50** is unvented and the diaphragm is flexed solely by aspiration or reduced pressure in the mixing passage **12**.

By placing the spring **98** close to the fulcrum pin **88**, a comparatively stiff spring **98** may be used and yet retain a high degree of sensitivity of control of the fuel inlet valve **85**. The fuel chamber **50** is made as shallow as practicable and is disposed close to the mixing passage **12** to secure response of the diaphragm to low aspiration for delivering fuel into the mixing passage, and to reduce to a minimum the hydrostatic head of liquid fuel on the diaphragm. The upper wall of the fuel chamber **50** is fashioned with a recess **100** to accommodate swinging movement of the lever **90**.

The carburetor is inclusive of a main nozzle or orifice construction for intermediate and high speed engine operation, the construction being preferably fashioned as a removable unit **102**, shown in FIGURES 2, 6 and 8, and a secondary or supplementary fuel delivery system including engine idling and low speed orifices, shown in FIGURE 2, to facilitate idling of the engine and low speed operation. The main or primary nozzle arrangement or unit **102** includes a check valve construction for preventing back bleeding of air into the secondary fuel delivery system when the latter is delivering fuel into the mixing passage.

The main nozzle unit **102** is inclusive of a cylindrically-shaped fitting or cage **104** formed of brass or other suitable material snugly fitted or press fitted into a bore **106**, as shown in FIGURE 6. The fitting **104** is provided with an axial bore **108** extending partially through the fitting. Arranged axially with the bore **108** is a counterbore **110** which accommodates a ball check valve **112**. The bore **108**, being of lesser diameter than the counterbore **110**, provides an annular ledge or seat **114** for the ball valve **112**.

Disposed in the upper or fuel delivery end of the fitting **104** is a grid **118** through which fuel is delivered into the mixing passage from the passages or bores in the fitting for normal and high speed engine operation.

As shown in FIGURE 2, the outlet or orifice **116** of the fitting **104** opens into the choke band region **18** of the Venturi **16** in the mixing passage. In assembly, the ball valve **112** is disposed in the counterbore **110**, the grid member **118** disposed in position and the upper peripheral region of the fitting swaged to hold the grid **118** in place.

The grid **118** is spaced above the ball valve **112**, a sufficent distance to facilitate movement of the valve from the seat **114** to provide for fuel flow around the valve. The ball check valve **112** is preferably fashioned of light weight material, such as nylon (polyamide resin) or polyoxymethylene (Delrin) so that the check ball will be lifted off of its seat under the influence of minimum lift or differential pressure. The fitting **104** is provided with a circumferential or peripheral recess **120** and transversely extending bores **122** establishing communication between the central bore **108** and the recess **120**.

When the secondary orifice system is delivering fuel into the mixing passage, the check ball **112** seats on the ledge **114** and thereby prevents air bleeding through the main nozzle **116** into the secondary orifice system.

FIGURE 8 illustrates channel means and manually adjustable valve means for conveying and regulating fuel flow to the main fuel delivery unit **102**. The body **10** is fashioned with a boss **126** having a bore **128** threaded to receive the threaded portion of a manually adjustable valve or valve body **130**.

The bore **128** is in communication with a fuel chamber **50** by a passage or channel **132** and a restricted passage **134** connects the bore **128** with the peripheral recess **120** in the fitting **104**. The valve body **130** is provided with a needle valve portion **136** which cooperates with the restriction **134** to meter or regulate flow of liquid fuel to the interior of fitting **104** for delivery into the mixing passage.

A counterbore in the boss **126** accommodates a sealing ring **140** surrounding the valve body **130**. The valve body **130** is provided with a manipulating head **142**, and an expansive coil spring **144** is disposed between the head and the sealing gasket **140** to exert pressure on the seal to prevent fuel seepage or leakage of air along the valve body. By reason of aspiration or reduced pressure in the mixing passage **12** under normal operating conditions fuel flows from the fuel chamber **50** through passage **132**, the bore **128**, restriction **134**, recess **120**, transverse bores **122** into the central bore **108** in the fitting for delivery past the check valve **112** into the mixing passage and mixed with air providing a combustible mixture.

The supplemental or secondary fuel delivery system is inclusive of a supplemental chamber **150**, shown in FIGURES 2 and 9, an engine idling orifice **152** and a low speed orifice **154** being in communication with the supplemental chamber **150**.

The engine idling orifice **152** delivers fuel into the mixing passage on the downstream or engine side of the throttle valve 34 for engine idling purposes, and the low

speed orifice **154** delivers fuel into the mixing passage when the throttle valve **34** is opened a slight amount for low speed engine operation. The lower end of the chamber **150** is closed by a Welsh plug **156**.

FIGURE 9 illustrates the fuel channels and manually adjustable valve means for conveying and metering fuel flow to the engine idling and low speed orifices. The boss **126** is provided with a bore **162** threaded to receive the threaded portion of a valve body **164** having a manipulating head **165**. A channel **166** establishes communication between the fuel chamber **50** and the bore **162**. A restricted passage **168** connects the bore **162** with the supplemental or auxiliary chamber **150**.

The valve body **164** is provided with a needle valve portion **169** which cooperates with the restriction **168** for metering or regulating fuel flow to the supplemental chamber **150**. A sealing ring **163** is biased into sealing engagement with the valve body **164** by a coil spring **167**. Thus, for engine idling and low speed engine operation, fuel flows through channel **166**, bore **162**, past the needle valve **169** through restriction **168** into the supplemental chamber **150** for delivery through the orifices **152** and **154**.

As shown in FIGURES 2, 3 and 4, the fuel pump is of the diaphragm type and is of the character shown in Phillips' Patent 2,796,838. The pump includes the pump body **60** which has an annular recess providing a fuel receiving chamber **170**, a cap **171** being secured to the pump body.

The cap **171** is provided with a nipple portion **172** to accommodate a tube (not shown) connected with a fuel tank or fuel supply. A screen **173** extends across the chamber **170** for filtering the incoming fuel.

The pumping diaphragm **62** is connected by channel means **181** through the mounting flange **42** with an opening in the engine crankcase **46** whereby the pumping diaphragm **62** is pulsated or vibrated by varying fluid pressures in the engine crankcase for pumping fuel through the chamber **66**. The pumping diaphragm **62** is provided with an integral inlet valve **174** which controls a port in communication with the fuel chamber **170**, and an integral outlet valve **175** controlling an outlet port in the pump body **60** whereby fuel is pumped from the pumping chamber **66** past the outlet valve **175** and through the connecting passages **78**, **79** and **80** to the region of the inlet valve **85**, shown in FIGURE 3.

The carburetor is inclusive of a valved passage or bypass between the main orifice **116** and the fuel chamber **50** for supplying additional fuel for delivery through the main orifice to provide for increased fuel delivery into the mixing passage and enrichment of the fuel and air mixture under wide open throttle conditions at low engine speed under load and for purpose of engine acceleration. The arrangement for supplying additional fuel is shown in FIGURES 5 and 6. The upper wall of the fuel chamber **50** is fashioned with a partial cylindrically-shaped recess **176** which is in communication with a counterbore **178**

The counterbore **178** is adjacent a smaller counterbore **180**, the counterbore **180** being in communication with the peripheral recess **120** in the fitting **104** through a restricted passage **182**. Disposed at the entrance of the first counterbore **178** is a screen or grid **184**. Loosely disposed in the counterbore **178** is a check valve or ball valve **186**. It will be seen in FIGURE 6 that the recess **176**, the connecting counterbores and the restriction **182** are axially aligned on the axis A—A which is disposed at an angle relative to a horizonal plane substantially parallel with the diaphragm **52**.

By disposing the bore **178** containing the check ball **186** at an inclination to a horizontal plane with the carburetor in upright position, the ball valve **178** normally falls by gravity to an open position to provide a passage or bypass for fuel flow to the main nozzle direct from the fuel chamber **50** in addition to the fuel normally delivered to the main nozzle through the channel and needle valve arrangement shown in FIGURE 8.

In the operation of the arrangement of valved fuel bypass construction with the engine operating at normal or high speeds, the aspiration, reduced pressure or suction developed in the mixing passage by air velocity therethrough is sufficient to lift and maintain the check ball **186** onto its seat at the entrance of the counterbore **180** to interrupt or block fuel flow through the bypass restriction **182** to the main nozzle.

When the engine is operating at comparatively low speeds under load and the throttle valve is opened rapidly there is insufficient aspiration or suction in the Venturi acting on the main nozzle to seat the ball check member **186**, and fuel flows direct from the fuel chamber **50** past the ball check valve **186** through the restriction **182** for delivery from the main orifice construction through the main orfice outlet **116** to thereby enrichen the mixture in the mixing passage being delivered to the engine.

The fuel enriched mixture causes rapid acceleration of the engine. As the engine approaches the speed for which the throttle is adjusted, the aspiration or suction increases in the Venturi and the aspiration or reduced pressure, transmitted through the passages in the main orifice unit construction **102** and the restriction **182**, is sufficient to maintain the ball valve **186** in its seat and thereby interrupt fuel flow through the bypass restriction **182**.

Under another condition, viz. the throttle being substantially open and the engine operating under load at low speed, the aspiration or suction in the mixing passage is insufficient to hold the ball valve **186** in its seat, and hence additional liquid fuel from the fuel chamber **50** flows through the open restriction or passage **182** and through the main nozzle **116** to provide a full power or enriched fuel and air mixture in the mixing passage at low air flow.

The ball check valve **186** is always in open position during engine idling because the aspiration or suction in the mixing passage at the region of the main orifice is of low amplitude when the throttle is in closed or near closed position. Under conditions where the speed of the engine increases generally in proportion to the position of opening of the throttle valve, fluel flow through the bypass or restriction **182** continues only until the pressure differential between the main nozzle **116** and the fuel chamber **50** is sufficient to lift the ball check valve **186** onto its seat.

The differential pressure which will cause the ball valve **186** to be lifted onto its seat is, in a measure, dependent upon the weight of the ball valve and the size of the restriction **182**. It is found desirable to fashion the restriction **182** of a size to provide sufficient fuel to provide an enriched mixture for acceleration purposes. The check ball **186** may be made of a material such as nylon or Delrin as a check ball fashioned of these materials has been found to be influenced by comparatively low aspiration or suction in the mixing passage to interrupt the flow of liquid fuel through the bypass **182** without overenriching the mixture, a condition which would lower the efficiency of the engine in lieu of the intended purpose of securing increased acceleration through a properly enriched mixture.

If it is desired to maintain an enriched mixture until the engine reaches a higher speed with a consequent increase in air velocity through the mixing passage, the ball valve **186** may be made of metal so that higher aspiration or suction in the mixing passage is required to elevate the ball valve **186** onto its seat. The check ball **186** is made of a material of greater density than the liquid fuel so that the ball normally falls away from its seat by gravity.

FIGURE 11 illustrates a modified form of valved fuel passage or bypass for admitting additional fuel into the mixing passage under certain operating conditions. In the form shown in FIGURE 11, the valved bypass is em-

bodied in the main orifice unit construction. In this form the carburetor body 10' is fashioned with a bore 106' and snugly fitted or pressed into the bore 106' is a fitting 190 similar in shape to the fitting 104, shown in FIGURE 6. The fitting 190 is fashioned with a central bore 192 and a peripheral recess 194, the bore being in communication with the recess through transverse passages 196.

The peripheral recess 194 receives fuel in the normal manner from the fuel chamber 50' through a fuel channel and metering valve arrangement of the character shown in FIGURE 8 and hereinbefore described. The upper portion of the fitting 190 is fashioned with a counterbore 198 of larger diameter in which is loosely disposed a ball valve 200 which seats on the ledge 201 between the bore 192 and the counterbore 198.

The ball valve 200 is adapted to prevent back bleeding of air through the main nozzle into the secondary fuel delivery system when the latter is delivering fuel into the mixing passage.

A grid 202 is mounted in the orifice 204 of the fitting and prevents dislodgement of the back bleeding check valve 200. The lower portion of the fitting 190 is provided with a counterbore 208 of larger diameter than the bore 192 and is in communication therewith. An annular ledge or seat 210 is formed at the juncture of the bores 192 and 208 and provides a seat for a ball check valve 212 of lesser diameter than the bore 208 to facilitate fuel flow around the ball valve 212 when it is out of engagement with its seat 210.

Disposed beneath the ball check valve 212 at the lower end of the fitting 190 is a Welsh plug 214 or other closure means provided with a fuel passage 216 opening into the fuel chamber 50' and preferably offset from the axis of the bore 208 so that when the ball valve 212 is engaged with the Welsh plug 212, such engagement will not impede or block flow of fuel through the passage 216. The ball valve 212 is loosely disposed in the counterbore 208 and is enabled to fall by gravity away from its seat into contact with the Welsh plug 214 so as to permit the admission of fuel through the passage 216 for delivery through the outlet or orifice 204 into the mixing passage.

The arrangement shown in FIGURE 11 functions substantially in the same manner as the arrangement shown in FIGURES 5 and 6. Under normal engine operation the fuel is admitted into the recess 196 from a fuel channel system of the character shown in FIGURE 8. When the engine is idling, the ball valve 212 is in engagement with the Welsh plug 214 under the influence of gravity. If the throttle valve is suddenly opened, the air velocity through the mixing passage is low and does not establish sufficient suction or aspiration to elevate the ball valve 212 onto its seat 210.

Hence, during the period of acceleration of the engine, additional fuel flows from fuel chamber 50' through the passage 216, bores 208, 192 and 198 around the ball valves 212 and 200 and is delivered through the main orifice 204 to enrich the mixture in the mixing passage. A similar condition obtains when the engine is operating under heavy load at low speed so that additional fuel flows through the bypass and past the valves 212 and 200 into the mixing passage.

As the engine increases in speed, the aspiration or reduced pressure becomes greater in the mixing passage to an extent as to elevate the ball 212 into engagement with the valve seat 210 thereby interrupting or blocking further delivery of additional fuel by way of the bypass arrangement into the mixing passage.

During normal or high engine speeds, the ball valve 212 is maintained in fuel blocking position by high aspiration or suction existent in the mixing passage. The engine, during such periods receives the normal mixture of fuel delivered through the conventional channel system and past the manual metering and regulating valve shown in FIGURE 8.

It is to be understood that the enrichment valve arrangement is not limited to use in a diaphragm type carburetor but may be utilized in carburetors wherein float controlled valve means is employed for regulating fuel flow from a supply into the carburetor fuel chamber.

It is apparent that, within the scope of the invention, modifications and different arrangements may be made other than as herein disclosed, and the present disclosure is illustrative merely, the invention comprehending all variations thereof.

I claim:

1. In combination, charge forming apparatus including a body having a mixing passage, an unvented fuel chamber in said body, a flexible impervious diaphragm responsive to aspiration in the mixing passage and forming a wall of the fuel chamber, a fuel inlet for the fuel chamber, an inlet valve for the fuel inlet, means associated with the diaphragm engageable with the fuel inlet valve for regulating flow of liquid fuel from a supply into the fuel chamber, a fuel delivery orifice opening into the mixing passage, fuel channel means in said body arranged to deliver fuel from the fuel chamber into the mixing passage through said orifice, manually adjustable valve means for regulating fuel flow through said fuel channel means into the mixing passage, a fuel bypass in said body for conveying fuel from the fuel chamber into the mixing passage independently of fuel flow regulated by the manually adjustable valve means, the axis of the bypass being angularly arranged with respect to the diaphragm, said bypass including a counterbore providing a valve seat in said bypass, and a ball valve of lesser diameter than the counterbore disposed for free movement in the counterbore, said ball valve being loosely disposed below said valve seat and normally maintained by gravity out of engagement with the valve seat, said ball valve being responsive to increased aspiration in said mixing passage to engage the ball valve with the valve seat to interrupt fuel flow through the bypass.

2. In combination, a charge forming apparatus including a body having a mixing passage, an unvented fuel chamber in said body, a flexible impervious diaphragm responsive to aspiration in the mixing passage forming a wall of the fuel chamber, a fuel inlet for the fuel chamber, an inlet valve for the fuel inlet, means associated with the diaphragm engageable with the fuel inlet valve for controlling flow of liquid fuel from a supply into the fuel chamber, orifice means opening into the mixing passage, fuel channel means in said body arranged to deliver fuel from the fuel chamber into the mixing passage through the orifice means, means associated with said fuel channel means for metering fuel flow through the channel means, a fuel bypass independent of said fuel metering means in communication with the fuel chamber and the mixing passage, said fuel bypass including a valve chamber formed with a valve seat, a ball valve disposed for free movement in said valve chamber, said ball valve being loosely disposed below said valve seat and normally spaced from its seat by gravity to accommodate flow of additional fuel through the bypass into the mixing passage under low aspiration in the mixing passage, said ball valve being influenced by increased aspiration in the mixing passage for interrupting fuel flow through said fuel bypass.

3. In combination, charge forming apparatus including a body having a mixing passage, an unvented fuel chamber in said body, a flexible impervious diaphragm forming a wall of the fuel chamber, a fuel inlet for the fuel chamber, an inlet valve for the fuel inlet, means associated with the diaphragm engageable with the fuel inlet valve for regulating flow of liquid fuel from a supply into the fuel chamber, a fitting in an opening in said body having an outlet providing a main orifice for delivering fuel into the mixing passage, a secondary orifice in said body opening into the mixing passage, said fitting having a passage in communication with the outlet, fuel channel means in said body for conveying fuel from said fuel chamber to

the passage in said fitting and to said secondary orifice, manually adjustable valve means associated with the fuel channel means for regulating fuel flow to the passage in said fitting, a fuel bypass for conveying fuel from the fuel chamber direct to the fuel passage in said fitting, said fitting being fashioned with counterbores providing two valve seats, a first valve means comprising a ball member in one counterbore in said fitting for preventing back bleeding of air through the main orifice when the secondary orifice is delivering fuel into the mixing passage, and a second valve means comprising a ball member in the second counterbore for said fuel bypass responsive to aspiration in the mixing passage for controlling fuel flow through the bypass.

4. The combination according to claim 3 including a

closure for the end of the fitting adjacent the second counterbore, and a fuel passage in said closure offset from the axis of said second counterbore.

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