March 5, 1968 R. K. TURNER 3,371,658

PRIMING METHOD AND ARRANGEMENT FOR FUEL FEED SYSTEM

Filed March 17, 1966 2 Sheets-Sheet 1

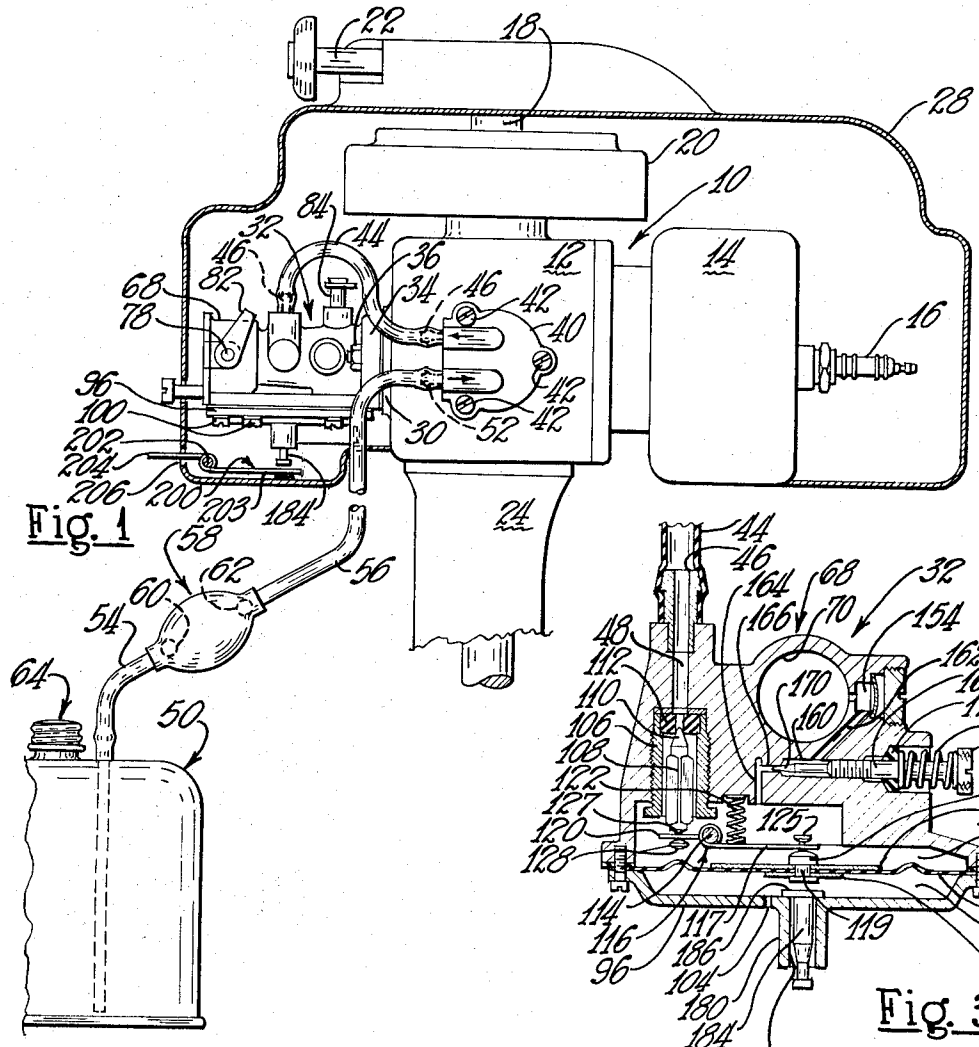


Fig. 1

Fig. 3

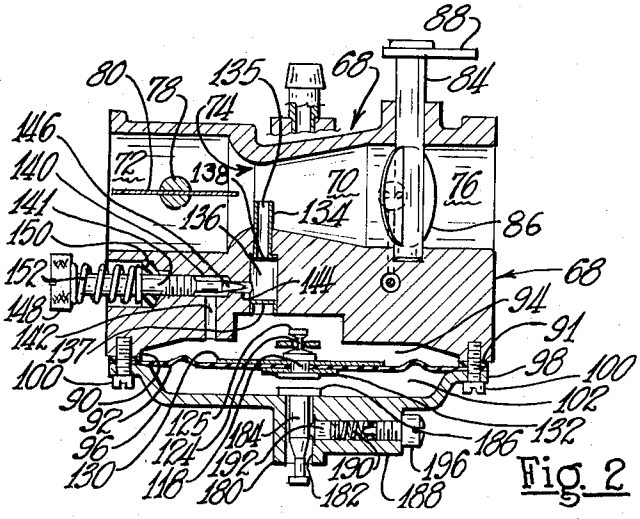


Fig. 2

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PRIMING METHOD AND ARRANGEMENT FOR FUEL FEED SYSTEM

Filed March 17, 1966 2 Sheets-Sheet 2

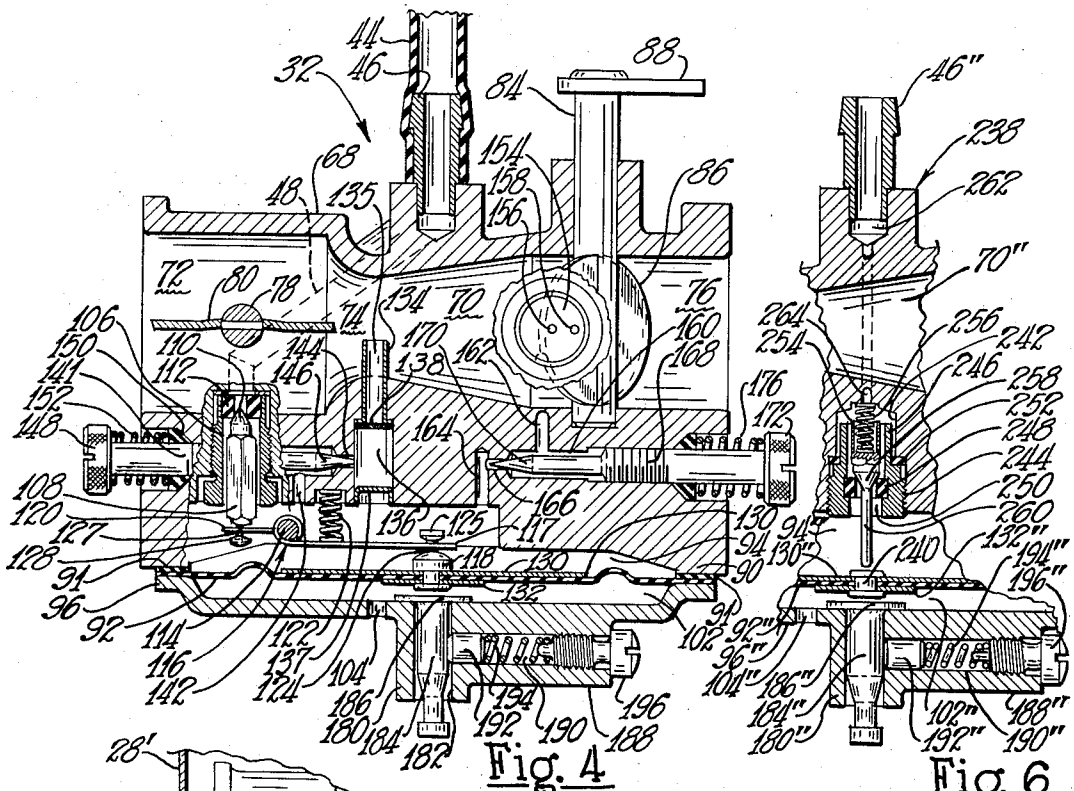


Fig. 4

Fig. 6

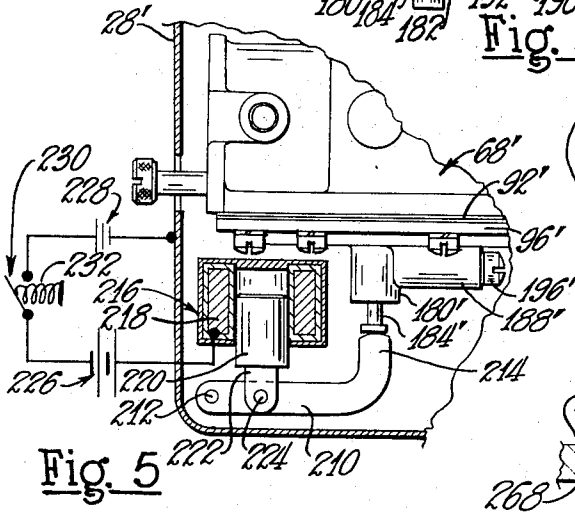


Fig. 5

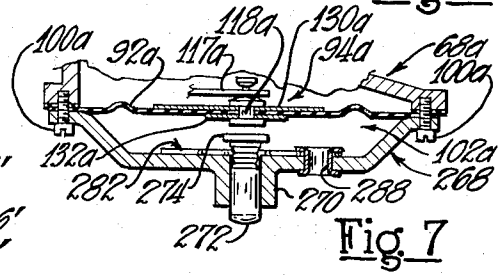


Fig. 7

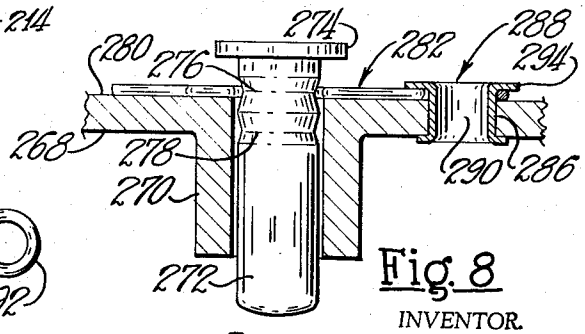


Fig. 8

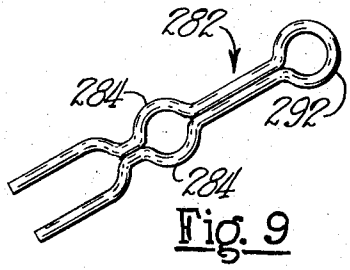


Fig. 9

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PRIMING METHOD AND ARRANGEMENT FOR FUEL FEED SYSTEM

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Filed Mar. 17, 1966, Ser. No. 535,203
11 Claims. (Cl. 123—187.5)

ABSTRACT OF THE DISCLOSURE

This invention relates to a priming method and arrangement for an aspirated type of diaphragm carburetor wherein the diaphragm controls a fuel inlet valve and an actuable member is provided to move the diaphragm to open the inlet valve and a manual priming pump actuated to purge the fuel line of air and fill the fuel chamber with fuel from a supply and establish fuel pressure in the fuel chamber sufficient to release the member from engagement with the diaphragm.

This invention relates to a priming method and arrangement for a fuel feed system especially of the character for supplying liquid fuel and air mixture to an internal combustion engine and more particularly to a priming arrangement associated with a fuel feed system embodying a diaphragm type carburetor or charge forming apparatus wherein the regulation or metering of fuel into the mixing passage of the carburetor or charge forming apparatus is controlled by engine aspiration or reduced pressure in the mixing passage.

The invention has particular utility with fuel feed systems of internal combustion engines of the character employed for marine or outboard installations, stationary engines and engines for powering small vehicles or the like where the fuel tank is disposed below the carburetor or charge forming apparatus and wherein priming is usually necessary in order to initiate the operation of the internal combustion engine.

Priming devices have been employed with charge forming apparatus for outboard marine engines particularly of the two cycle type embodying so-called float-type carburetors wherein the fuel level in a vented bowl of the carburetor is regulated by a float-controlled inlet valve. One form of priming arrangement has been used with a diaphragm type carburetor by employing a vent means externally of the carburetor for purging the fuel feed lines of air in order to facilitate starting of the engine, an arrangement of this character being disclosed in Phillips Patent 3,177,920. In such vented fuel feed priming systems, some fuel is lost during the priming operation as the operator can only determine by overflow of fuel through the vent tube to the atmosphere when the system has been purged of air. The venting or extrusion of fuel to the atmosphere during such a priming operation involves a fire hazard as well as the loss of fuel attendant each priming operation. An aspirated type of diaphragm carburetor embodies a fuel inlet valve which is normally held in closed position by a spring. The fuel chamber of an aspirated diaphragm carburetor is unvented and it is difficult or sometimes impossible to develop sufficient pressure upon a manual squeeze bulb priming pump to overcome the pressure of the inlet valve spring to effect fuel flow into the fuel chamber of the carburetor to initiate operation of the engine.

The present invention embraces a method, arrangement or system associated with an aspirated diaphragm carburetor or charge forming apparatus and a fuel pump arrangement whereby entrapped air in the fuel feed lines or tubes is vented into the carburetor mixing passage through the fuel inlet valve to facilitate easy starting of the engine with which the carburetor is used.

Another object of the invention resides in an aspirated diaphragm carburetor and fuel feed system embodying an arrangement for relieving closing pressure on the inlet valve of the carburetor to enable the venting of the fuel supply line through the carburetor thereby preventing loss of fuel during a priming operation in initiating starting the internal combustion engine.

Another object of the invention is the provision of a method of priming a diaphragm type carburetor for engine starting purposes wherein priming is effected without loss of fuel to the atmosphere whereby potential fire hazard is substantially eliminated.

Another object of the invention resides in a priming arrangement for an aspirated type diaphragm carburetor wherein a diaphragm controlled fuel inlet valve normally spring biased toward closed position is relieved of spring pressure enabling a squeeze bulb primer to be readily manipulated to purge the fuel supply line of air through the inlet valve of the carburetor and when fuel delivered by the squeeze bulb primer fills the fuel chamber and exerts pressure on the diaphragm to close the inlet valve, the operator is apprised by increased resistance encountered in manipulating the squeeze bulb that the priming operation is completed.

Another object of the invention resides in a fuel priming arrangement for an aspirated type diaphragm carburetor wherein the fuel inlet valve of the carburetor is controlled by a movable diaphragm subject to engine aspiration in association with spring means normally urging the inlet valve to closed position, the arrangement embodying means for moving the diaphragm to a position effecting opening of the inlet valve to facilitate fuel delivery into the fuel chamber, which means is automatically restored to its ineffective position by fuel pressure when the fuel chamber is filled and thereby facilitating easy starting of the engine with which the carburetor is used.

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 semidiagrammatic illustration of an outboard type of marine engine and diaphragm carburetor and a priming arrangement of the invention associated therewith;

FIGURE 2 is a longitudinal sectional view of a carburetor or charge forming apparatus illustrating one form of fuel inlet valve releasing means forming a component of the priming arrangement of the invention;

FIGURE 3 is a transverse sectional view through the carburetor shown in FIGURE 2;

FIGURE 4 is an enlarged schematic sectional view through the carburetor illustrating a manually operated diaphragm actuator for relieving pressure normally closing the fuel inlet valve;

FIGURE 5 illustrates an electrically energizable means for actuating the diaphragm to relieve pressure normally closing the fuel inlet valve;

FIGURE 6 is a fragmentary sectional view illustrating a modified arrangement of fuel inlet valve in association with a diaphragm actuator for relieving pressure normally closing the fuel inlet valve;

FIGURE 7 is a sectional view through a portion of a diaphragm type carburetor illustrating a modified form of diaphragm actuator for relieving pressure normally closing the fuel inlet valve;

FIGURE 8 is an enlarged fragmentary sectional view of a portion of the construction shown in FIGURE 7, and

FIGURE 9 is an isometric view of a spring detent forming a component of the construction shown in FIGURES 7 and 8.

While the priming method, arrangement or system of the invention has particular utility with diaphragm carburetors for supplying fuel and air mixture to two cycle or four cycle marine engines of the outboard type, it is to be understood that the invention may be utilized with diaphragm carburetors for supplying fuel to internal combustion engines for other uses where priming means is essential or desirable for engine starting purposes.

Referring to FIGURE 1 of the drawings, there is illustrated in semidiagrammatic form an arrangement or system utilizing an aspirated-type diaphragm carburetor and fuel delivery arrangement for feeding fuel and air mixture to an internal combustion engine for the outboard marine type where the fuel supply tank is disposed beneath the level of the carburetor requiring fuel pumping means to deliver fuel from the tank to the carburetor.

In FIGURE 1 there is illustrated an internal combustion engine **10** of the two cycle type which is inclusive of a crankcase **12**, a cylinder **14** secured to the crankcase, provided with a spark plug **16** for igniting the charge in the cylinder. A crankshaft **18** of conventional construction is journaled in the crankcase, the engine being provided with a piston and connecting rod (not shown). The engine crankshaft **18** is equipped with a flywheel **20** and a pulley (not shown), the latter provided with a cable **22** associated with the pulley for manually starting the engine in a well known manner.

A hollow strut **24** carried by the crankcase **12** depends therefrom and encloses an extension of the crankshaft for transmitting power to a propeller (not shown) provided at the lower end of the strut **24**. A sheet metal housing **28** encloses the engine and associated components. The crankcase **12** is fashioned with a boss **30** which mounts the charge forming apparatus or diaphragm carburetor **32**, a flange **34** on the carburetor mating with the boss **30**, the carburetor being secured to the crankcase by bolts **36**, one of which is shown in FIGURE 1.

In the arrangement shown in FIGURE 1, a fuel pump **40** is secured to the crankcase **12** by screws **42**, the pump being preferably of the diaphragm type in which the diaphragm is actuated by varying fluid pressure in the crankcase **12** of the two cycle engine **10**. A diaphragm pump of the character shown in Phillips' Patent 2,796,838 may be employed for the purpose. A flexible tube or pipe **44** connects the outlet **46** of the fuel pump with a fitting **46** at the entrance of an inlet duct **48** in the carburetor body.

A fuel tank or fuel supply receptacle **50** is disposed below the carburetor **32** and is connected with an inlet fitting **52** on the fuel pump by tubular means or tubes **54** and **56** and a priming pump **58**, the latter being of flexible squeeze bulb type connected with the tubes **54** and **56** as shown in FIGURE 1. The priming pump means or squeeze bulb **58** is of conventional construction provided with inlet and outlet check valves **60** and **62**. When squeeze pressure is applied to the bulb **58**, liquid fuel from the receptacle is delivered through the fuel pump

40 and into the carburetor through the tube **44** under conditions hereinafter described.

A manually operated vent valve **64** is provided for venting the fuel tank **50** during engine operation, the valve **64** being manually rotatable to a closed position when the engine is not in operation.

The carburetor shown in FIGURES 1 through 3 and illustrated in a schematic or expanded section in FIGURE 4 is of the aspirated type, that is, a diaphragm type carburetor having an unvented fuel chamber and wherein the diaphragm is influenced by aspiration or reduced pressure in the mixing passage of the carburetor established by engine operation. The carburetor **32** is inclusive of a body **68** provided with a mixing passage **70** having an air inlet region **72**, a venturi **74** and a mixture outlet **76**, the latter registering with a passage in the boss **30** on the engine crankcase **12**, the passage being provided with the conventional reed valve construction employed in a two cycle engine.

A shaft **78** journaled in openings in the body **68** extends across the air inlet region **72** and is equipped with a conventional disc-type choke valve **80** employed for restricting the air inlet **72** during engine starting operations. The choke shaft **78** is equipped with a manipulating arm **82**. A shaft **84** journaled in bores in the body **68** extends across the mixture outlet passage **76** and is equipped with a disc-type throttle valve **86** of conventional construction for controlling delivery of fuel and air mixture into the crankcase of the engine. The throttle shaft **84** is equipped with a manipulating arm **88** for controlling the position of the throttle valve **86**.

The carburetor body **68** is formed with a generally circular wall portion **90**, the planar face of which forms a seat for an annular gasket **91**.

A diaphragm **92** of flexible impervious material, such as a nylon fabric impregnated or coated with a synthetic rubber-like material or resin, is disposed with its peripheral region contiguous with the gasket **91** and extends across the region defined by the wall portion **91** which forms a fuel chamber or recess **94**. As shown in FIGURES 2, 3 and 4, the flexible diaphragm **92** forms a wall of the fuel chamber **94**.

The fuel chamber **94** is unvented and is in communication with the mixing passage through fuel delivery orifices hereinafter described. The fuel chamber **94** is comparatively shallow to minimize the distance between the diaphragm **92** and the mixing passage **70** to provide a minimum of fuel head on the diaphragm. A cover member or closure plate **96** has a peripheral portion **98** contiguous with the periphery of the diaphragm **92**. The gasket **91**, diaphragm **92** and the closure member **96** are fashioned with aligned openings accommodating securing screws **100** threaded into openings in the carburetor body **68** for securing these components in assembled relation.

The closure **96** is recessed to provide a space or air chamber **102** to accommodate flexing movements of the diaphragm **92**. The air chamber **102** is vented to the atmosphere through a vent opening **104** as shown in FIGURE 3. The diaphragm **92**, under the influence of varying pressures or aspiration in the fuel chamber **94**, is arranged to control a fuel inlet valve to regulate fuel flow into the fuel chamber **94** for delivery through orifices into the mixing passage **70**.

Threaded into a bore in the carburetor body **68** is a valve guide member or sleeve **106** in which is slidably disposed a valve member or valve body **108** having a tapered or needle valve portion **110** which cooperates with an annular valve seat **112**, these components being illustrated in FIGURES 3 and 4. The valve body **108** is of polygonal cross section, for example, square cross section, to facilitate fuel flow along the valve body into the fuel chamber **94**. Disposed in the fuel chamber **94** and fulcrumed upon a pin **114** is a lever or motion transmitting member or means **116**.

The long arm **117** of the lever is adapted for engagement with a member **118** mounted on the diaphragm **92**, the short arm **120** of the lever having operative engagement with the valve body **108**. A coil spring **122** has one end seating in a recess in the body **68**, as shown in FIGURE 3, the opposite end of the spring engaging the long arm **117** of the lever **116**, the pressure of the spring urging the lever **116** for pivotal movement about its fulcrum pin **114** in a clockwise direction as viewed in FIGURE 3 to normally bias or urge the inlet valve **110** toward closed position or seating engagement with the ported valve seal **112**.

The end region of the long arm **117** of the lever is preferably bifurcated or provided with an open ended slot, the furcations straddling a tenon **124** terminating in a head portion **125** providing an articulate connection between the diaphragm button **118** and the lever.

The short arm **120** of the lever may also be bifurcated, the furcations straddling a tenon **127** formed on the valve body **88**, the lower end of the tenon terminating in a head portion **128** establishing an articulate connection between the lever **116** and the inlet valve body **108**.

Disposed at each side of the diaphragm **92** are disc-like members or washers **130** and **132** of metal or other substantially rigid material for reinforcing the diaphragm, the button **118** having a shank portion **119** extending through aligned openings in the reinforcing discs and diaphragm for securing these components in assembled relation.

The carburetor is provided with primary and secondary fuel delivery systems including orifice means for high speed engine operation and for low speed and engine idling purposes. With reference to FIGURES 2 and 4, a main fuel discharge tube **134** opens into the choke band or restricted region of the Venturi **74** providing a main orifice **135**. The lower end of a bore **136** in the body **68** below the tube **134** is closed by a plug **137**. Formed adjacent the air inlet end of the carburetor is a channel **140** in which is disposed a valve body **141** having a threaded portion engaging a threaded region of a channel **140** whereby the position of the valve body **141** may be adjusted.

A fuel passage **142** connects the channel **140** with the fuel chamber **94**. A restricted passage **144** is disposed between the bore **136** and the channel **140**. The valve member **141** is provided with a needle valve portion **146** extending into the restriction **144**. A fine mesh screen **138** is disposed at the entrance of the main orifice delivery tube **134** to provide a capillary seal to prevent back bleeding of air through the main orifice **135** when the secondary orifice system is delivering fuel into the mixing passage.

The needle valve **146** regulates or meters fuel flow from the chamber **94** to the main orifice **135** provided by the tube **134**. The valve body **141** is provided with a knurled head **148** for manipulating the valve.

A sealing gasket **150** surrounds the valve body **141**, and a coil spring **152** interposed between the head **148** and the sealing gasket **150** provides friction for holding the valve in an adjusted position. The valve **146** provides fuel adjustment for normal and high speed engine operation.

The secondary fuel delivery system for low speed and engine idling purposes is inclusive of a supplemental chamber **154**, a low speed orifice **156** and an engine idling orifice **158** opening into the mixing passage in the region of the throttle valve **86**, as shown in FIGURES 2 and 4. As particularly shown in FIGURES 3 and 4, the body **68** is fashioned with a bore or channel **160** which is in communication with the supplemental chamber **154** through a duct **162**. The bore or channel **160** is in communication with the fuel chamber **94** by a passage **164** and a restricted passage **166**.

Disposed in the bore **160** is a valve body **168** having a threaded portion cooperating with a threaded portion of the bore **160**. The valve body **168** is fashioned with a needle valve portion **170** which extends into and cooperates with the restriction **166** for regulating, metering or controlling the delivery of fuel into the supplemental chamber **154** for discharge into the mixing passage through one or both orifices **156** and **158** of the secondary fuel delivery system. The valve body **168** is provided with a knurled head **172** for manipulating the needle valve **170**.

A sealing gasket **174** surrounds the valve body **168**, and an expansive coil spring **176** disposed between the head **172** and the gasket **174** provides sufficient friction to hold the valve body **168** in adjusted position. The needle valve **170** provides adjustment for engine idling and low speed operation. A stop means (not shown) of conventional construction is associated with the throttle shaft **84** for adjusting the engine idling position of the throttle valve **86** in a conventional manner.

The invention is inclusive of a novel method and means for purging the fuel supply lines or tubes of air in order to effect delivery of fuel from a supply into the carburetor for delivery into the mixing passage to facilitate easy starting of the engine with which the carburetor is used. In the arrangement of the invention the purging of the fuel lines or tubes of air is effected internally of the carburetor by moving the diaphragm to disengage the inlet valve **110** from its valve seat to vent air in the fuel lines through the inlet port of the carburetor.

Means is provided for actuating or flexing the diaphragm in a direction to overcome the pressure of the spring **122** and open the inlet valve **110**. The diaphragm closure plate **96** is fashioned with a centrally disposed boss portion **180** fashioned with a bore **182** in which is slidably disposed a diaphragm actuating means which, in the form shown in FIGURES 2 through 4, is a plunger or member **184** having a head or disc-like portion **186** disposed within the air or dry chamber **102** between the diaphragm **92** and the closure plate **96**.

The plate **96** is formed with a second boss portion **188** provided with a bore **190** in which is slidably disposed a member or detent **192**, one end of which frictionally engages a cylindrical wall of the plunger **184**. Disposed in the bore **190** is an expansive coil spring **194** biasing or urging the detent **192** into engagement with the pin or plunger **184**. The bore **190** has a threaded wall portion accommodating a threaded plug **196** which engages the other end of the spring and maintains the spring under compression to provide a biasing force effective on the detent or plunger **192**.

The diaphragm actuating means or plunger **184** is adapted to be manually pushed upwardly to project a portion of the plunger into the chamber **102** by the operator exerting upward pressure upon the lower end of the plunger **184**. Upward movement of the plunger engages the head **186** thereof with the diaphragm button or member **118** and flexes the diaphragm upwardly, swinging or pivoting the lever **116** in a counterclockwise direction about its fulcrum **114**, as viewed in FIGURES 3 and 4, compressing the spring **122** and opening the fuel inlet valve **110** to facilitate purging the fuel lines of air and admit fuel past the fuel inlet valve.

Sufficient biasing pressure is exerted by the spring **194** on the detent or member **192** to overcome the pressure of the lever-biasing spring **122** so as to maintain the diaphragm **92** in an uppermost position of flexure to which it is moved by upward movement of the plunger **184** so that the inlet valve **110** will be held open by the frictional force of the detent **192** against the plunger **184**.

In the arrangement shown in FIGURE 1, the sheet metal housing **28** embraces the carburetor and a supplemental means accessible exteriorly of the housing may be employed to actuate the plunger **184** to elevate the diaphragm **92**. As shown in FIGURE 1, a member or lever **200** pivoted upon a pin or fulcrum **202**, supported by means (not shown) has an arm **203** adjacent the end of the plunger **184**, the other arm **204** extending through an

opening **206** in the housing **28** provides a means for actuating or elevating the plunger **184**.

The operation of the priming arrangement shown in FIGURES 1 through 4, in starting the engine with which the carburetor is used is as follows: The fuel lines or tubes **44**, **54** and **56** connecting the carburetor and the fuel pump and connecting the fuel pump and the fuel tank **50** may contain air making it difficult, if not impossible, to develop sufficient reduced pressure or aspiration in the carburetor mixing passage by manual rotation of the engine crankshaft to lift fuel from the tank **50** to start the engine.

In using the priming method and arrangement of the invention, the operator moves the lever **200**, shown in FIGURE 1, in a counterclockwise direction to engage the lever arm **203** with the member or plunger **184** to elevate the plunger. Upward movement of the plunger engages the head **186** thereof with the member **119** at the central region of the diaphragm and flexes the diaphragm upwardly.

The upward flexure or movement of the diaphragm pivots or swings the lever **116** in a counterclockwise direction as viewed in FIGURES 3 and 4, overcoming the biasing pressure of the spring **122** and opening the valve **110**.

The detent or retaining member **192**, being under pressure of the expansive spring **194**, establishes sufficient friction between member **192** and the plunger **184** to hold the plunger **184** in its uppermost or valve-opening position. It is to be understood that the spring **194** is calibrated to exert sufficient pressure on the detent **192** whereby the friction between the detent and the member **184** is adequate to hold the spring **122** in compressed condition with the fuel inlet valve **110** in open position.

The operator then exerts repeated squeeze pressure on the flexible squeeze bulb primer or priming pump **58** to pump or elevate fuel through the tubes **54**, **56**, **44** and through the fuel pump to the region of the inlet valve. As the inlet valve **110** is in open position, any air in the fuel conveying tubes is first exhausted through the inlet valve followed by flow of liquid fuel past the valve **110** into the fuel chamber **94**. The chamber **94** is rapidly filled with fuel and the air therein exhausted or vented from the fuel chamber through the fuel channels of the primary system past the valve **146** and through the main orifice **135** into the mixing passage, and through the fuel channels of the secondary system past the valve **170** into the mixing passage through the secondary orifices **156** and **158**.

The air in the chamber **94** readily flows through these orifices into the mixing passage to purge the chamber **94** and the fuel supply lines of air. When the fuel chamber **94** is filled with liquid fuel, the resistance to flow of liquid fuel past the metering valves **146** and **170** of the carburetor becomes substantial and fuel pressure buils up in the chamber **94** acting against the diaphragm **92**.

As the area of the diaphragm **92** is substantial, the fuel pressure built up in chamber **94** overcomes the frictional force of the detent **192** maintaining the plunger **184** in elevated position. The diaphragm **92**, under the fuel pressure, is flexed downwardly and moves or returns the plunger **184** to its initial position shown in FIGURES 2 through 4. During downward flexure or movement of the diaphragm **92**, the lever **116** is pivoted in a clockwise direction as viewed in FIGURES 3 and 4 assisted by the pressure of the spring **122**, which movement closes the inlet valve **110**.

The closing of the inlet valve **110** sets up substantial resistance to squeeze pressure on the priming squeeze bulb or pump **58**, indicating to the operator that the fuel lines are filled with liquid fuel, that the chamber **94** is filled with liquid fuel and that the fuel chamber and fuel lines have been purged of air vented into the mixing passage. The operator then manipulates the engine starting cable **22** to effect starting of the engine in the usual manner.

Thereafter during normal carburetor and engine operation, the spring biased detent **192** frictionally retains the plunger **184** in its out-of-use position as shown in FIGURES 2, 3 and 4. Through the method and arrangement of purging or venting the fuel lines and fuel chamber of air into the mixing passage of the carburetor, there is no loss or waste of fuel as the operator is immediately informed by increased resistance to squeeze bulb pressure that the inlet valve **110** has been closed and the system purged of air.

FIGURE 5 illustrates power means for actuating the plunger to elevate the diaphragm and open the fuel inlet valve **110** during a priming operation. The carburetor and diaphragm actuating plunger arrangement of FIGURE 5 is the same as illustrated in FIGURES 2 through 4. The carburetor body **68'** is equipped with a metering diaphragm **92'** and a closure plate **96'** configured to provide an air chamber beneath the diaphragm to accommodate flexing of the diaphragm. The cover **96'** is fashioned with a boss **180'** in which is slidably disposed the diaphragm actuator or plunger **184'** of the construction shown in FIGURES 2 through 4.

The cover **96'** is fashioned with a hollow boss **188'** accommodating a spring biased detent of the character shown in FIGURES 2 through 4, the detent-engaging spring being held in compression by the screw **196'**. The arrangement is provided with a sheet metal enclosure **28'** of the character shown in FIGURE 1.

Disposed adjacent and beneath the plunger **184'** is a member or lever **210** pivotally mounted or fulcrumed upon a pivot pin **212**, the pin being mounted upon a suitable support (not shown).

The distal end region **214** of the lever extends upwardly and terminates adjacent to or in contact with the lower end of the plunger **184'**. Supported by suitable means (not shown) is a solenoid **216** of conventional construction which is inclusive of a coil **218** and a movable core **220**, a projection or tenon **222** of the core being pivotally connected by a pin **224** with the lever **210**. A circuit for the solenoid is schematically illustrated including a source of direct current, such as a battery **226**, connected with the coil **218** and to a usual ground connection **228** which may be the housing **28'** or other metal part of the engine.

The solenoid circuit includes a normally open switch **230**, biased to open position by a spring **232**. The core **220** is in a normal out-of-center position with respect to the coil **218** as shown in FIGURE 5. The arrangement shown in FIGURE 5 is employed with the carburetor, fuel pump and fuel line system and squeeze bulb primer of the character shown in FIGURE 1.

In the use of the arrangement shown in FIGURE 5, the operator manually closes the switch **230** which completes the circuit through the solenoid coil **218** energizing the coil to effect upward movement of the core **220** into the central region of the coil.

Upward movement of the solenoid core **220** swings the lever **210** about its fulcrum **212**, the portion **214** of the lever engaging and moving the plunger **184'** upwardly to engage and move the metering diaphragm **92'** in the carburetor upwardly to open the fuel inlet valve in the carburetor.

The operator then manipulates the squeeze bulb **58**, shown in FIGURE 1, and purges the fuel lines and the carburetor fuel chamber of air in the manner hereinabove described.

The switch **230** is closed only momentarily by the operator to effect upward movement of the plunger **184'** through the media of the solenoid **216** and the lever **210**, the plunger **184'** being held in its diaphragm engaging position by a spring biased detent of the character shown in FIGURE 4. The spring **232** automatically opens the switch **230** when the operator releases closing pressure on the switch.

FIGURE 6 illustrates the diaphragm actuator arrangement in combination with a modified form of fuel inlet

valve for the carburetor. The carburetor body **238** is generally of the character of the carburetor body **68** shown in FIGURES 2 and 3, the body having a mixing passage **70''** of the same shape as the mixing passage **70** shown in FIGURE 2. The carburetor is provided with a fuel chamber **94''**, a metering diaphragm **92''** and a cover plate **96''** for the diaphragm, the cover plate being of the character shown in FIGURE 2.

The cover plate is provided with a vent opening **104''** to the atmosphere to equalize the pressure in the air chamber **102''** between the cover **96''** and the diaphragm **92''**. The cover plate **96''** is fashioned with a depending hollow boss **180''** in which is slidably mounted a plunger or member **184''** having a head portion **186''**. The diaphragm **92''** is equipped with reinforcing discs **130''** and **132''** disposed at opposite sides of the diaphragm and secured thereto by a rivet **240**.

The cover plate **96''** is fashioned with a boss portion **188''** provided with a bore **190''** accommodating a slidable member or detent **192''** biased toward the plunger **184''** by an expansive spring **194''**, an abutment screw **196''** threaded into the bore **190''** maintains the spring under compression. The friction established at the region of contact of the detent **192''** with the plunger **194''** is sufficient to maintain the diaphragm **92''** in its uppermost position during priming operations.

In this form of construction the carburetor body **238** is equipped with an inlet nipple or fitting **46''** adapted to be connected with the fuel pump by a flexible tube, such as the tube **44** shown in FIGURE 1. The central region of the carburetor body **238** is fashioned with a bore **242**, the axis of which is aligned with the center of the diaphragm **92''**. A counterbore in the carburetor body is threaded as at **244** to accommodate a fitting **246**. The fitting **246** is provided with a ledge forming an abutment positioning an annular valve seat **248** in a bore **250** in the fitting **246**.

A sealing gasket **252** is provided between the fitting **246** and the ledge provided at the entrance of the bore **242**. Slidably disposed within the bore **250** and above the annular valve seat **248** is a valve body **254** bored to accommodate an expansive coil spring **256**. The valve body **254** is fashioned with a needle valve portion **258** providing an inlet valve adapted to seat in the annular valve seat **248** as shown. The valve body **254** is provided with a depending stem or projection **260** which terminates adjacent the rivet **240** with the diaphragm in its normal or neutral position.

The inlet fitting **46''** is fitted into a bore **262** in the carburetor body and the bore **262** is in communication with the bore **242** by a duct, passage or channel **264** partially encircling the mixing passage **70''** to conduct fuel from the fuel pump or supply through the inlet fitting **46''** to the region of the inlet valve **258**. When the diaphragm **92'** is in neutral position, that is, when it is not influenced by aspiration in the mixing passage, the inlet valve **258** is closed and the terminus of the stem **260** is adjacent the upper surface of the rivet **240**.

When the diaphragm is subjected to engine aspiration in the mixing passage, the diaphragm is flexed upwardly and opens the valve **258** to admit fuel into the fuel chamber **94''**. The spring **256** exerts only minimum pressure sufficient to bias the inlet valve **258** to closed position, the minimum biasing pressure being readily overcome by upward movement of the diaphragm **92''** when the latter is subjected to engine aspiration.

The arrangement shown in FIGURE 6 is manipulated in the same manner as the arrangement shown in FIGURES 2 through 4 in priming the engine. The operator first moves the plunger **184''** upwardly engaging the head **186''** thereof against the rivet **240** flexing the diaphragm upwardly, concomitantly moving the plunger **260** and the inlet valve **258** upwardly to open the valve for purging the fuel lines of air and admit fuel into the chamber **94''**.

A squeeze bulb priming member **58** (shown in FIGURE 1 is actuated by the operator to effect fuel delivery from a supply tank through the fuel pump to the chamber **94''** until the chamber is filled with fuel and the diaphragm **92''** flexed downwardly by the fuel pressure to effect a closing of the inlet valve **258**, completing the priming operation.

FIGURES 7 through 9 illustrate a modified arrangement of spring means and diaphragm actuating plunger for elevating the diaphragm and opening the fuel inlet valve of the carburetor during priming operations. The carburetor body **68*a*** is equipped with a metering diaphragm **92*a*** of the character shown in FIGURES 2 and 3, the diaphragm being reinforced by discs **130*a*** and **132*a***, the discs and diaphragm being held in assembled relation by a rivet operatively engaged with an inlet valve operating lever **117*a*** which controls a fuel inlet valve for the carburetor in the manner shown in FIGURE 3.

The diaphragm **92*a*** is enclosed by a cover plate **268**, screws **100*a*** securing the plate **268** and diaphragm **92*a*** in assembled relation with the carburetor body **68*a***. The cover plate **268** is shaped to provide an air chamber **102*a*** to accommodate flexing movements of the diaphragm. The central region of the plate **268** is fashioned with a depending boss **270** bored to slidably accommodate a diaphragm actuator or plunger **272**, the plunger having a head portion **274** for engagement with the rivet **118*a*** at the central region of the diaphragm.

The plunger **272** is fashioned with two spaced circumferential grooves or recesses **276** and **278** as particularly shown in FIGURE 8. Disposed adjacent and contiguous with the upper surface **280** is a hairpin-like member **282** of spring wire having semicircular loop portions **284** straddling the plunger **272** and of a dimension to selectively and resiliently engage in the circumferential grooves **276** and **278** shown in FIGURE 8. The plate **268** is provided with a bore **286** accommodating a hollow rivet **288**, the central opening **290** in the rivet providing a vent opening for the air chamber **102*a***.

The bore **286** in the plate **268** is in registration with a closed loop **292** provided at the return bend at one end of the hairpin spring **282**. The head **294** of the hollow or tubular rivet is of large area to embrace the portion of the spring member adjacent the loop **292** in order to secure the spring member **282** in contiguous engaging relation with the upper surface **280** of the plate **268**.

As shown in FIGURE 8, the intermediate semicircular portions **284** of the spring member **282** are engaged in or form detents extending into the upper circumferential recess **276** in the plunger **272** to normally maintain the plunger **272** out of engagement with the diaphragm to allow normal flexure of the diaphragm during operation of the engine.

In effecting a priming operation of the engine, the operator first manually moves the plunger **272** upwardly to disengage the spring portions **284** from the recess **276** and engage the spring portions **284** in the circular recess **278**. In the upper position with the spring engaged in the recess **278**, the diaphragm **92*a*** is moved to open the inlet valve through the lever **117*a*** and arrangement of the character shown in FIGURE 3 preparatory to the operator actuating the squeeze bulb **58** of the priming system to purge the fuel lines of air and effect fuel flow into the fuel chamber **94*a***.

The inward pressure of the spring or detent portions **284** is sufficient to overcome the biasing pressure of the spring **122**, shown in FIGURE 3, to frictionally maintain the fuel inlet valve in open position and the plunger **272** in its uppermost position with the spring in registration with the circumferential groove **278**. When the fuel chamber **94*a*** is filled with liquid fuel through the operator's actuation of the squeeze bulb **58**, shown in FIGURE 1, fuel pressure is developed in the chamber forcing the diaphragm **92*a*** downwardly to move the plunger **272** downwardly.

This movement disengages the spring portions **284** from the circumferential groove **278** and causes the spring portions **284** to snap into the groove **276** to retain the plunger in its out-of-use position during normal engine operation.

Thus, in the forms of the invention illustrated herein, the diaphragm is actuated by a plunger to an uppermost position to open the inlet valve and is held in such valve-opening position until fuel flow into the carburetor by manipulation of the squeeze bulb or primer **58**, develops pressure in the fuel chamber to flex the diaphragm downwardly and restore the diaphragm actuator or plunger to its out-of-use position. Through the use of the method and arrangement of the invention, air in the fuel lines, fuel pump and fuel chamber in the carburetor is exhausted, vented or discharged through the orifices **135**, **136** and **158** into the mixing passage, and the small amount of fuel that may flow through the orifices into the mixing passage at the completion of a priming operation is not lost to the atmosphere but will be taken into the engine upon starting the engine. With the arrangement of the invention the operator is immediately informed of the completion of a priming operation by the substantial increased resistance to compression of the squeeze bulb or priming pump **58**. Loss of fuel to the atmosphere is prevented and a potential fire hazard eliminated.

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. The method of purging air from the fuel supply line connecting a fuel tank with an aspirated type diaphragm carburetor wherein the diaphragm regulates a fuel inlet valve to control fuel flow into a fuel chamber in accordance with the aspiration in the mixing passage of the carburetor including the steps of actuating a movable body from an initial position to move the diaphragm to a position opening the fuel inlet valve, establishing friction on the movable body to releasably maintain the diaphragm in valve opening position, actuating a priming pump connected in the fuel supply line to force any air in the fuel line past the open inlet valve through the fuel chamber into the mixing passage, and thereafter continuing actuation of the priming pump until the fuel chamber is filled with fuel and sufficient fuel pressure established in the fuel chamber to move the diaphragm to close the fuel inlet valve and release the movable body to its initial position away from the diaphragm.

2. The method according to claim **1** wherein the body is manually actuated to move the diaphragm to a position opening the fuel inlet valve.

3. A fuel feed system including a carburetor, a fuel pump arranged to receive liquid fuel from a fuel tank, a manually operable priming pump, tubular means connecting the priming pump with the fuel pump and the fuel tank, duct means for conveying fuel from the fuel pump to the carburetor, said carburetor having a mixing passage and a fuel chamber, a flexible diaphragm forming a wall of the fuel chamber, said fuel chamber being unvented whereby said diaphragm is responsive to aspiration in the mixing passage, a fuel inlet valve in the carburetor, resilient means normally biasing the inlet valve to closed position, means transmitting movements of the diaphragm to the inlet valve to control fuel flow into the fuel chamber in accordance with the aspiration in the mixing passage, passage means in said carburetor for delivering fuel from the fuel chamber to the mixing passage, a member normally out of engagement with the diaphragm, said member being operable to move the diaphragm to open the inlet valve, and friction means engaging said member for retaining the diaphragm in valve-opening position until the fuel chamber is filled with fuel and fuel pressure established in the fuel chamber by manual operation of the priming pump sufficient to move the diaphragm to close the inlet valve and release said member from engagement with the diaphragm.

4. The combination according to claim **3** including a cover for the diaphragm, the member operable to move the diaphragm being a plunger reciprocably mounted in a bore in the cover, and resilient means cooperating with the plunger establishing friction for releasably retaining the diaphragm in valve-opening position when said plunger is actuated to move the diaphragm to open the fuel inlet valve.

5. Charge forming apparatus including, in combination, a body having a mixing passage, an unvented fuel chamber in the body, a flexible diaphragm forming a wall of the fuel chamber, passage means for conveying liquid fuel from the fuel chamber into the mixing passage, a fuel inlet in the body, a valve for the inlet, tubular means for conveying liquid fuel from a source to the inlet, a priming pump connected with the tubular means for pumping fuel into the fuel chamber, said diaphragm being responsive to aspiration in the mixing passage, means transmitting movement of the diaphragm to the inlet valve to control the position of the inlet valve, resilient means normally biasing the inlet valve toward closed position, a movable member supported adjacent the diaphragm and adapted to be actuated to engage the diaphragm and move the diaphragm to a position opening the inlet valve, and means cooperating with the member for releasably maintaining said diaphragm in valve-opening position, said priming pump being actuable to fill the chamber with fuel and establish sufficient pressure in the fuel chamber effective to move the diaphragm toward inlet valve closing position and release the member from engagement with the diaphragm.

6. The combination according to claim **5** including a cover for the diaphragm, said cover having a bore therein, the diaphragm actuating member being slidably mounted in said bore, said releasable means including a detent engageable with the member effective to retain the member in engagement with the diaphragm, the retaining force of said detent means being of a value to permit retractive movement of said member by the establishment of fuel pressure in the fuel chamber by the priming group.

7. The combination according to claim **5** including a cover for the diaphragm, the cover having a hollow boss, the movable member being a plunger slidably mounted in the hollow boss, said plunger being adapted to be moved to a position engaging and actuating the diaphragm to open the inlet valve to provide fuel flow into the fuel chamber, and friction means for retaining the plunger in diaphragm engaging position, said plunger being released to a retracted position by said diaphragm when the fuel pressure in the fuel chamber established by actuation of the priming pump overcomes the force of the friction means, and a vent for venting the region between the cover and the diaphragm.

8. The combination according to claim **6** wherein the cover is provided with a second bore adjacent the member, the detent being movable in the second bore for engagement with the diaphragm actuating member, and resilient means in said second bore biasing the detent means into engagement with the member.

9. The combination according to claim **6** wherein the member is a plunger provided with a recess, and spring means disposed in the recess for resiliently retaining the plunger in diaphragm engaging position.

10. The combination according to claim **9** wherein the plunger is fashioned with a peripheral recess, a hairpin spring having portions straddling the plunger, said straddling portions engageable with the recess in the plunger for resiliently retaining the plunger in diaphragm engaging position.

11. The combination according to claim **10** including a tubular eyelet passing through the eye of the hairpin spring and an opening in the cover for securing the hairpin

spring to the cover, the tubular eyelet providing a vent opening for the space between the cover and the flexible diaphragm.

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