Sept. 27, 1966 W. D. NUTTEN 3,275,305

FUEL FEED AND CHARGE FORMING APPARATUS WITH PRIMING DEVICE

Filed May 3, 1965 3 Sheets-Sheet 1

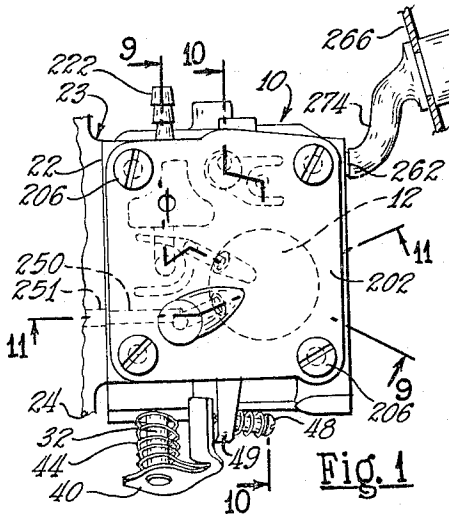


Fig. 1

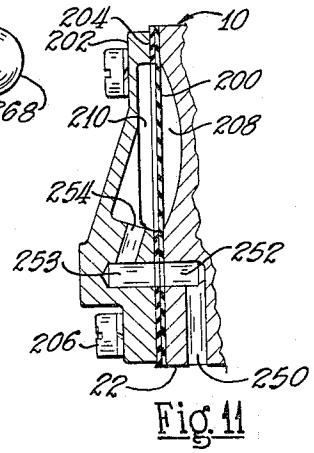


Fig. 11

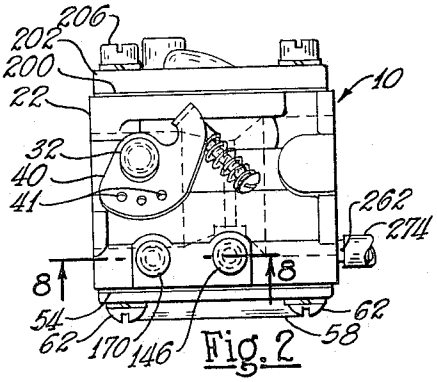


Fig. 2

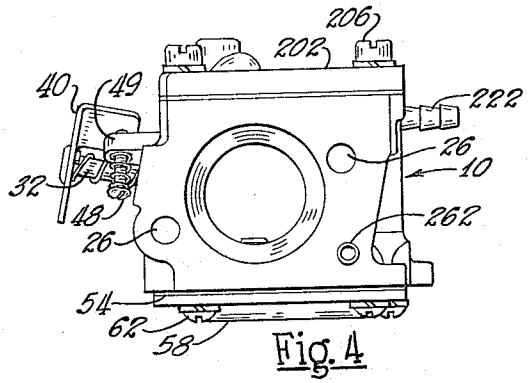


Fig. 4

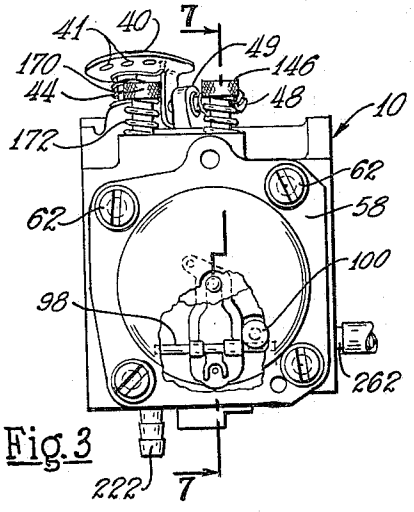


Fig. 3

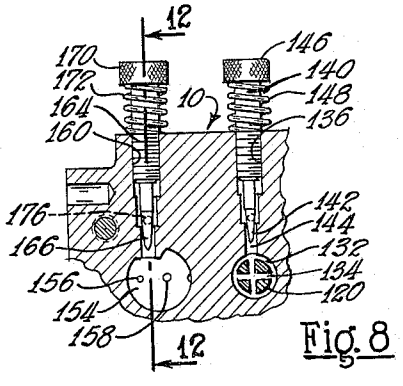


Fig. 8

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FUEL FEED AND CHARGE FORMING APPARATUS WITH PRIMING DEVICE

Filed May 3, 1965 3 Sheets-Sheet 2

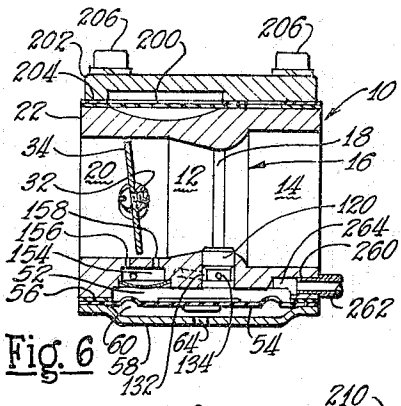


Fig. 6

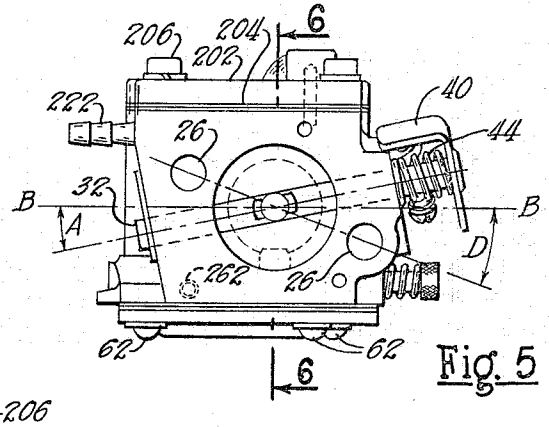


Fig. 5

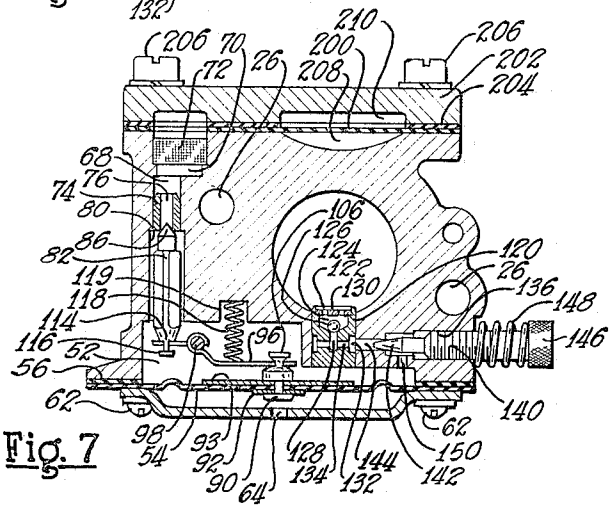


Fig. 7

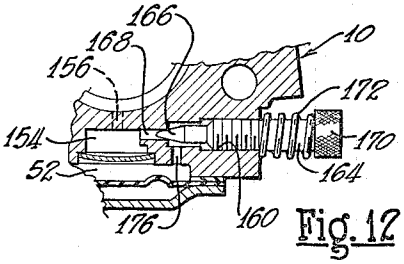


Fig. 12

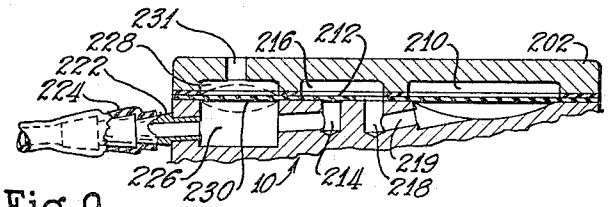


Fig. 9

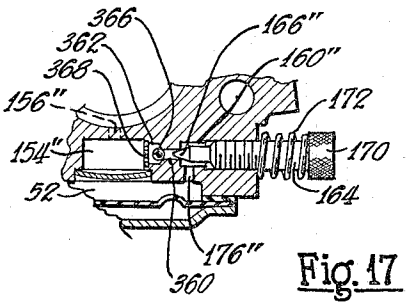


Fig. 17

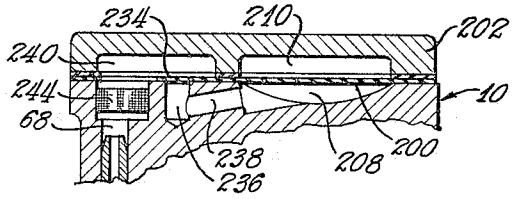


Fig. 10

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FUEL FEED AND CHARGE FORMING APPARATUS WITH PRIMING DEVICE

Filed May 3, 1965 3 Sheets-Sheet 3

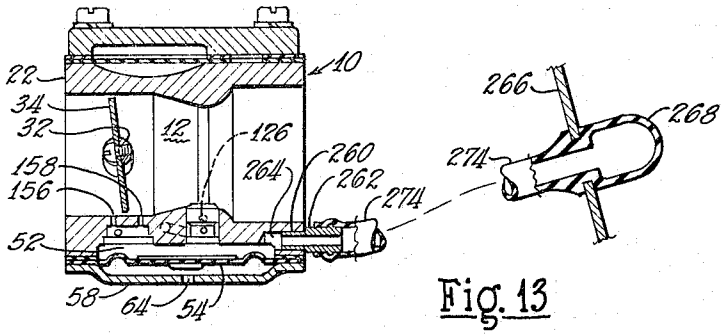


Fig. 13

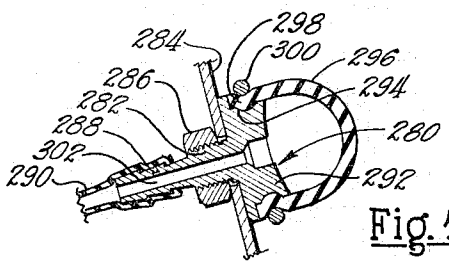


Fig. 14

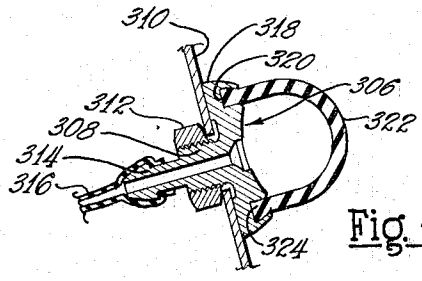


Fig. 15

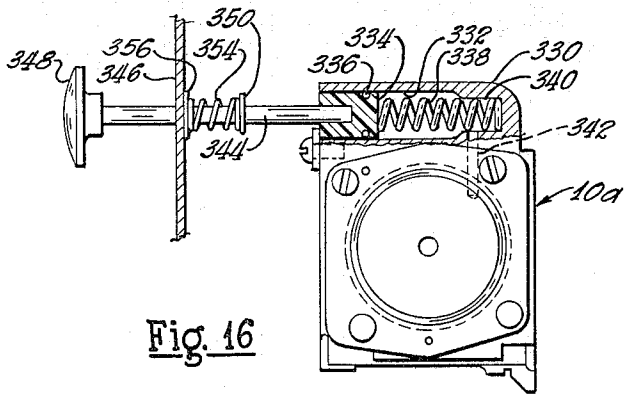


Fig. 16

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FUEL FEED AND CHARGE FORMING APPARATUS WITH PRIMING DEVICE

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Filed May 3, 1965, Ser. No. 452,826
5 Claims. (Cl. 261—34)

This invention relates to fuel feed and charge forming apparatus for delivering fuel and air mixture to an internal combustion engine and more especially to an apparatus of this character embodying a priming device for manually injecting liquid fuel into a fuel and air mixing passage to facilitate starting an internal combustion engine with which the fuel feed and charge forming apparatus is used.

Charge forming apparatus of a character embodying a diaphragm responsive to aspiration in a mixing passage for controlling delivery of fuel into the mixing passage has heretofore been provided with a so-called choke valve to reduce air flow to the mixing passage in order to enrich the mixture for engine starting operations. A conventional choke valve comprises a disc valve in the air inlet region of the carburetor mixing passage mounted on a rotatable shaft provided with a manipulating arm for manually moving the choke valve to substantially closed position during starting operations.

By temporarily closing the air inlet, the engine aspiration is effective during manual cranking of the engine to effect the delivery of fuel to enrich the mixture for engine starting purposes. An arrangement of this type of choke valve mechanism has been employed with diaphragm type carburetors wherein, during engine cranking operations and particularly engines of the two cycle type, the aspiration or reduced pressure created by manual cranking of the engine acts upon the diaphragm to eventually effect delivery of fuel into the mixing passage in sufficient quantity to provide a rich mixture for starting the engine. In the use of two cycle engines, such as those used for powering chain saws, lawn mowers, outboard motors for marine use and the like, it usually requires many cranking revolutions of the engine by manual means, particularly under cold weather conditions, to effect a starting of the engine. This difficulty is particularly present in the starting of chain saw engines, employing diaphragm type carburetors, particularly in cold temperatures, as power saws of this character are conventionally used in felling trees in winter weather. As chain saw engines are portable, such engines embody a manual means for rotating the engine to effect starting, and the starting means have to be operated many times in cold weather to start the engine.

The present invention embraces a charge forming apparatus of the diaphragm type embodying a method of and means for establishing pressure in a fuel chamber in the charge forming apparatus to inject or deliver liquid fuel under pressure into the fuel and air mixing passage in advance of cranking the engine in order to promote easy starting of the engine with a minimum of effort upon the part of the operator.

Another object of the invention resides in a diaphragm carburetor embodying a priming means actuable by the operator and requiring little effort for positively injecting fuel from a fuel chamber into the mixing passage of the carburetor without the use of other mechanism and eliminating the conventional choke valve and its operating means.

Another object of the invention is the provision of a priming device embodied in a diaphragm type carburetor or charge forming apparatus which may be manipulated by the operator with comparatively little effort to effect

delivery of fuel for engine starting purposes into the mixing passage whether the carburetor fuel chamber is initially dry or whether it is necessary to effect the elevation of fuel from a fuel tank into the carburetor fuel chamber thence into the mixing passage and independent of cranking operations of the engine.

Another object of the invention resides in a fuel feed and charge forming apparatus embodying a priming means for manually and positively delivering liquid fuel into the mixing passage of the charge forming apparatus under pressure to positively provide an enriched fuel mixture for the engine and thereby enable easier starting of the engine.

Another object of the invention resides in a combined diaphragm type carburetor and priming device wherein a variable volume pressure chamber is employed to develop pressure in a fuel chamber in the carburetor to eject fuel under pressure into the mixing passage and wherein the fuel inlet valve of the carburetor functions to facilitate the establishment of pressure in the fuel chamber in providing for pressure injection of fuel into the mixing passage for engine starting purposes.

Another object of the invention resides in a priming device for a diaphragm type carburetor in which an operator actuated component may be positioned adjacent the carburetor or remote therefrom without impairing the utility or effectiveness of the priming device.

Another object of the invention resides in a priming device for a diaphragm carburetor having an unvented fuel chamber wherein the inlet valve for controlling fuel flow from a supply into the fuel chamber of the carburetor and valve means to prevent bleeding of air into the fuel delivery system assures the establishment of pressure in the fuel chamber by manipulation of the priming device by the operator for positively injecting fuel into the mixing passage preparatory to starting the engine.

Another object of the invention resides in the provision of a diaphragm carburetor of a priming device actuated by the operator for manually creating pumping pulsations or differential pressures in the fuel chamber of the carburetor effective to cause fuel flow from a supply to enter the diaphragm fuel chamber of the carburetor and eject such fuel under pressure into the mixing passage to provide an enriched mixture for engine operation.

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 or 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 fuel feed and charge forming apparatus or carburetor embodying one form of priming device of the invention;

FIGURE 2 is a side elevational view of the fuel feed and charge forming apparatus shown in FIGURE 1;

FIGURE 3 is a bottom plan view of the construction shown in FIGURES 1 and 2 with certain portions broken away;

FIGURE 4 is an elevational view of the air inlet end of the construction shown in FIGURE 1;

FIGURE 5 is an elevational view of the mixture outlet end of the construction shown in FIGURE 1;

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

FIGURE 7 is a transverse sectional view taken substantially on the line 7—7 of FIGURE 3;

FIGURE 8 is a detail sectional view taken substantially on the line 8—8 of FIGURE 2;

FIGURE 9 is a detail sectional view taken substantially on the line 9—9 of FIGURE 1;

FIGURE 10 is a fragmentary detail sectional view taken substantially on the line 10—10 of FIGURE 1;

FIGURE 11 is a fragmentary detail sectional view taken substantially on the line 11—11 of FIGURE 1;

FIGURE 12 is a fragmentary detail sectional view taken substantially on the line 12—12 of FIGURE 8;

FIGURE 13 is a sectional view similar to FIGURE 6 illustrating a form of priming means associated therewith;

FIGURE 14 is a sectional view illustrating a modified form of priming device;

FIGURE 15 is a sectional view illustrating another modification of priming device of the invention;

FIGURE 16 is a bottom plan view of the charge forming apparatus or carburetor construction illustrating another form of priming device embodied therein, and

FIGURE 17 is a fragmentary sectional view similar to FIGURE 12 illustrating a check valve means associated with the secondary fuel delivery system.

While the priming device is illustrated as embodied in a fuel feeding apparatus and diaphragm carburetor of compact construction particularly usable for supplying combustible mixture to a chain saw engine of the two cycle type, it is to be understood that the priming device may be embodied in other forms of diaphragm carburetor which function generally in the same manner as the carburetor and fuel feed device disclosed herein.

Referring to the drawings in detail and initially to the form of the invention shown in FIGURES 1 through 13, the charge forming apparatus or carburetor component of the construction includes a body or body member **10** of cast metal or other suitable material fashioned with an air and fuel mixing passage **12** having an air inlet region **14**, a Venturi **16** providing a restricted region or choke band **18** and a mixture outlet **20**, as particularly shown in FIGURE 6.

The mixture outlet end of the carburetor has a uniplanar surface **22** which is adapted to mate with a boss portion **23** formed on the crankcase **24** of an engine of the two cycle type, or to mate with the entrance of a mixture inlet manifold of an engine of the four cycle type. The mixture outlet **20** registers with an opening in the boss portion **23** of the crankcase where the engine is of the two cycle type for delivering combustible mixture into the engine crankcase through a conventional reed valve construction (not shown) at the mixture admission opening.

The air inlet end **14** of the carburetor may be equipped with an air filter or air cleaner (not shown) of conventional construction. The carburetor body **10** is provided with two cylindrical bores or passage **26** extending entirely through the body and accommodating bolts (not shown) for securing the air filter to the carburetor body and securing the body to the engine crankcase, the bolts being threaded into suitable threaded bores (not shown) provided in the engine crankcase boss **23**.

Extending across the mixture outlet region **20** and journaled in bores in the body **10** is a shaft **32** supporting a disc-type valve **34** providing a throttle valve for regulating or controlling flow of fuel and air mixture to the engine. As shown in FIGURE 5, the axis of the throttle valve shaft **32** is disposed at an angle A with respect to a horizontal axis BB. A plane through the axes of the drilled passages or bores **26** is at an angle D with respect to the horizontal axis BB and in crossing relation with the axis of the shaft **32** so that the mounting bolts received in the bores **26** do not interfere with the fuel passages and channels formed in the carburetor body or interfere with the throttle shaft **32**.

A portion of the throttle shaft **32** exteriorly of the body **10** is equipped with an arm **40** for manipulating the throttle. If desired, a cable (not shown) may be connected with one of a series of openings **41** in the arm **40** for manipulating the throttle from a remote position.

A coil spring **44** is positioned between the body **10** and the arm **40**, one end being anchored to the body and the other end engaging the arm to normally bias the throttle valve toward near closed or engine idling position. An abutment screw **48** is threaded into an opening in a lug **49** on the body **10** for adjusting the engine idling position of the throttle valve.

As particularly shown in FIGURES 6 and 7, the body **10** is formed with a generally circular shallow chamber or recess **52** providing a fuel chamber in the body. A flexible member, diaphragm or membrane **54** extends across the recess and forms a flexible wall of the fuel chamber **52**, a gasket **56** being disposed between the peripheral region of the diaphragm and the portion of the body defining the chamber **52** to form a liquid tight seal. A cover member **58** has a depressed central region providing a space or air chamber **60** to accommodate flexing movement of the diaphragm.

A plurality of screws **62** extend through registering openings formed in the cover member **58**, the diaphragm **54** and the gasket **56** are threaded into suitable bores formed in the body **10** to secure these components in assembled relation. The cover member **58** has an opening **64** to vent the space or dry chamber **60** to the atmosphere. The diaphragm **54** is arranged to be actuated or flexed by aspiration or reduced pressure established in the mixing passage **12** for controlling or metering the flow or delivery of liquid fuel into the diaphragm fuel chamber **52**, the fuel chamber **52** being unvented.

The body **10** is provided with a fuel inlet duct **68** in communication with a fuel delivery passage of a fuel feed or pumping means hereinafter described, the duct **68** opening into an enlarged bore **70** accommodating a fuel filter or screen **72**, shown in FIGURE 7. Pressed or snugly fitted into the inlet duct **68** is a tubular member or sleeve **74** providing an inlet port **76**. The body is formed with a bore or passage **80** in which is slidably disposed an elongated valve body or valve member **82** of polygonally shaped cross section to facilitate flow of liquid fuel into the fuel chamber **52**.

The valve body is formed with a conically-shaped valve portion **86** adapted to cooperate with the port **76** in the sleeve **74** for metering fuel into the fuel chamber **52**. If desired, the member **74** may be made of nonmetallic material such as synthetic rubber or other suitable material. A motion multiplying means, such as a lever **96**, is fulcrumed intermediate its ends on a fulcrum pin **98** for communicating flexure or movement of the diaphragm **54** to the valve member **82** to control the position of the inlet valve **86** for regulating fuel flow into the chamber **52** in accordance with the degree of aspiration or reduced pressure established in the fuel chamber **52** from the mixing passage **12**.

As shown in FIGURE 7, a member **90** has a portion extending through a central opening in the diaphragm and through reinforcing discs **92** and **93** disposed at opposite faces of the diaphragm, and a portion of the member **90** swaged to secure these components in assembled relation. As shown in FIGURE 3, the head of a screw **100**, threaded into a bore in the body, secures the fulcrum pin within the fuel chamber **52**.

The long arm of the lever has a bifurcated or forked end engaging in a recess formed on the member **90**, the recess being defined by a head portion **106** on the member **90**, this arrangement establishing a positive articulate connection between the diaphragm **54** and the lever **96**. The short arm of the lever **96** has its extremity bifurcated or forked to straddle a tenon **114** formed on the lower end of the inlet valve body **82** and terminating in a head portion **116**.

Through the connection provided between the member **90** carried by the diaphragm and the long arm of the lever and the connection between the short arm of the lever and the valve body **82**, the valve body **82** is positively re-

sponsive to the flexing movements of the diaphragm **54** in either direction of flexing movement of the diaphragm. An expansive coil spring **118** has one end nested in a socket **119** formed in the body **10**, the spring, engaging the long arm of the lever adjacent the fulcrum, exerts a comparatively small force urging the inlet valve **86** toward closed position to normally interrupt fuel flow through the inlet port **74**.

Aspiration established in the mixing passage **12** is communicated through fuel passages to the chamber **52**, the reduced pressure or aspiration elevating the diaphragm **54** to swing the lever **96** in a counterclockwise direction as viewed in FIGURE 7 to open the inlet valve **86** to valve in fuel into the fuel chamber **52**.

The carburetor includes a main or primary fuel delivery system for delivering fuel into the mixing passage for normal and high speed engine operation, and a secondary fuel delivery system for engine idling and low speed operation. The main fuel delivery system embraces a main orifice construction which includes a cylindrically shaped fitting **120** pressed or snugly fitted into a bore in the body **10**, the fitting having an outlet region **122** providing a main fuel delivery orifice.

The fitting **120** is provided with a counter bore **124** in which is disposed a ball valve or check valve member **126** which, when the carburetor is in horizontal position as shown in FIGURE 7, seats against the ledge formed by a second counter bore or passage **128**, the ball check **126** being retained in the counter bore **124** by a grid-like retainer **130** in the orifice or outlet region **122**. The fitting **120** has a peripheral recess **132** which is in communication with the counter bore **128** by transverse passages **134**.

As shown in FIGURE 7, the body is provided with a threaded bore **135** accommodating a threaded portion of a high speed adjusting valve member **140**. The valve body is formed with a needle valve portion **142** which cooperates with a restricted passage **144** in communication with the recess **132** in the fitting **120**. The valve body **140** is fashioned with a knurled manipulating head **146**. A coil spring **148** is disposed between the body and the head **146** to establish sufficient friction to hold the valve member **140** in adjusted position. The bore **136** receives fuel from the chamber **52** through a duct **150**, shown in FIGURE 7.

The secondary fuel delivery system for engine idling and engine low speed operation is illustrated in FIGURES 6, 8 and 12. The body **10** is fashioned with a small supplemental chamber **154** which is in communication with a mixing passage by an engine idling orifice **156** and a low speed orifice **158**. As shown in FIGURE 12, the carburetor body is fashioned with a bore **160** having a threaded portion accommodating the threaded body of a valve member **164**, the latter having a needle valve portion **166** cooperating with a restricted passage **168** opening into the supplemental chamber **154**.

The valve member **164** is provided with a knurled manipulating head **170**, a coil spring **172** between the head **170** and the body providing friction for retaining the valve member in manually adjusted position.

The needle valve portion **166** cooperates with the restriction **168** to meter or regulate fuel flow into the supplemental chamber **154** for delivery through one or both of the secondary orifices **156** and **158**. Fuel is delivered into the bore **160** from the fuel chamber **52** through a passage or duct **176** shown in FIGURE 12.

Fuel delivery through the main orifice or delivery system takes place as follows with reference to FIGURE 7: Fuel from the chamber **52** flows through the duct **150** into the bore **136** past the needle valve **142** through the restricted passage **144**, the peripheral recess **132**, transverse passages **134**, counter bore **128** past the ball check valve **126** and through the opening **122** into the mixing passage **12** for mixing with air moving through the passage. The main orifice **122** opens into the choke band **18** of the Venturi **16**.

When the throttle valve **34** is in engine idling or low speed position fuel flow takes place as follows with reference to FIGURES 6 and 12: Fuel from the chamber **52** flows through the duct **176** into the bore **160** past the needle valve **166** through the restriction **168** and into the supplemental chamber **154** for delivery through either or both of the orifices **156** and **158**.

The normal function of the check ball or valve means **126** in the main orifice construction **120** is to prevent back bleeding of air through the main orifice into the secondary fuel channel system when one or both of the secondary orifices are delivering fuel into the mixing passage. Otherwise, air bled into the secondary fuel system through the main orifice would lean the idling fuel mixture to an extent causing the engine to stall.

The arrangement includes a fuel feeding means or fuel pump construction for supplying fuel under comparatively low pressure to the inlet duct **68** of the carburetor. The pumping means includes a flexible impervious diaphragm **200** disposed at the opposite side of the carburetor body from the fuel metering or control diaphragm **54**, the pumping diaphragm **200** engaging an upper planar surface region of the body **10**, as particularly shown in FIGURES 6 and 7. A sealing gasket **204** is disposed between a cover plate **202** and the pump diaphragm **200**.

The plate **202**, gasket **204** and the diaphragm **200** have registering openings accommodating securing bolts **205** threaded into bores in the body **10** to secure these components in assembled relation. The body **10** has a concave recess providing a fuel compartment **208**, the diaphragm **200** extending across the recess. The plate **202** is fashioned with a recess providing a pulse or pumping chamber **210**, the diaphragm **200** providing a flexible wall between the fuel compartment **208** and the pulsing or pumping chamber **210**.

The diaphragm **200** is fashioned with an integral flap valve **212** which controls fuel flow from a supply through an inlet port **214**, shown in FIGURE 9, the cover **202** having a recess **216** to accommodate opening movement of the flap valve **212**. The recess **216** is in communication with the fuel compartment **208** through connecting ducts **218** and **219**, shown in FIGURE 9.

The body **10** is provided with a hollow nipple **222** receiving one end of a flexible tube **224** providing a fuel line connected with a fuel tank or other fuel supply (not shown). Fuel flowing through the hollow nipple **222** enters a small supplemental compartment **226** in communication with the fuel inlet port **214**.

The plate **202** is formed with a recess **228**, a portion **230** of the pumping diaphragm forming a common wall between the supplemental chamber **226** and the recess **228**. The recess **228** may be vented to the atmosphere by a vent opening **231**. The supplemental chamber **226** forms a surge chamber or variable volume region, the diaphragm portion **230** forming a yielding medium for absorbing the surge pulses of the moving liquid fuel under the influence of the rapid opening and closing movements of the inlet flap valve under the pumping action of the pumping diaphragm.

The pumping diaphragm **200** is provided with a second integral flap valve portion **234** cooperating with an outlet port **236** in communication with the pump fuel compartment **208** by a passage **238**. A recess **240** in the cover plate **202** accommodates opening movements of the outlet flap valve **234** and forms a fuel passage to the carburetor fuel inlet duct **68**, as shown in FIGURE 10. A filter or screen **244** is disposed in a bore in the body **10** between the recess **240** and the inlet duct **68** for filtering the incoming fuel.

The pumping diaphragm is arranged to be actuated by varying fluid pressures occurring in the engine crankcase of the two cycle engine during engine operation. The duct arrangement for connecting the pulse chamber **210** with the source of varying fluid pressure is shown in FIG-

URE 11. A pulse passage or channel **250** formed in the body **10** has its entrance in the end of the carburetor body secured to the crankcase of the engine, the channel **250** being arranged to register with an opening **251** in the crankcase wall, shown in broken lines in FIGURE 1.

The channel **250** is in communication with the pumping chamber **210** through interconnecting channels **252**, **253** and **254**, which with the channel form a pulse passage to transmit pressure pulsations or varying fluid pressures in the engine crankcase to the pumping compartment **210**.

The varying pressures in the pumping chamber **210** cause rapid flexure or vibration of the region of the diaphragm **200** defining the flexible wall of the recess **210** to set up a fuel pumping action in the fuel chamber **208**. Through the varying fuel pressures developed in the fuel chamber **208** by pulsations of the diaphragm **200**, in cooperation with the inlet and outlet flap valves **212** and **234**, fuel from a supply enters the small chamber **226** from the hollow nipple **222** thence flows through the inlet **214** past the flap valve **212** through connecting ducts **218** and **219** through the fuel chamber **208**, through interconnecting ducts and past the outlet flap valve **234** to the region of the inlet duct **68** in the carburetor.

The flow of fuel through the inlet duct **68** into the fuel chamber **52** in the carburetor is regulated or controlled by the relative position of the metering diaphragm **54** which is influenced or actuated by reduced pressure in the mixing passage **12** for delivery into the mixing passage through the primary or secondary fuel delivery systems hereinbefore described. The surge chamber **226** provides for a more continuous and smooth flow of fuel through the fuel chamber **208** of the pumping means, the pumping diaphragm **200** being vibrated at high frequencies during engine operation by varying pressure at each revolution of the engine.

The carburetor and fuel pumping means of the charcter disclosed herein is usually employed with two cycle engines of the type used for powering chain saws, lawn mowers and the like and it is conventional practice to initiate starting of such engines by a manual means, rotating the engine several times until sufficient aspiration is developed to deliver fuel into the mixing passage from the chamber **52**. Heretofore it has been conventional practice, in order to temporarily develop high aspiration in the mixing passage and provide an enriched fuel mixture for starting, to utilize a choke valve to substantially close the air inlet and thereby increase the aspiration in the fuel delivery orifice means.

With a conventional choke valve arrangement it is usual that several manual rotations of the engine are required before an enriched ignitable mixture is delivered to the engine especially under low temperature conditions.

The present invention embodies a mannually actuable means for temporarily establishing increased pressure in the fuel chamber **52** to effect the positive injection from the fuel chamber of fuel under pressure into the mixing passage preparatory to starting the engine and without restricting the air inlet of the carburetor by a choke means.

FIGURE 13 illustrates one form of manually actuable variable volume means for establishing increased pressure in the fuel chamber **52** of the carburetor. The air inlet end of the body **10** adjacent the fuel chamber **52** is provided with a threaded bore **260** adapted to receive a hollow nipple **262**, the hollow interior of the nipple being in communication with the fuel chamber **52** through a connecting duct **264**.

Mounted upon a panel or other suitable support means **266** is a squeeze bulb molded or formed of synthetic rubber of a character which is not subject to deterioration by contact with hydrocarbon fuels, or fashioned of molded plastic having similar characteristics. The thickness of the wall of the squeeze bulb is sufficient to main-

tain the bulb **268** in its normal expanded condition as shown in FIGURE 13 but sufficiently thin to enable the operator to distort or collapse the bulb **268** by squeeze pressure or by finger pressure applied to the bulb.

In the embodiment illustrated in FIGURE 13 the squeeze bulb construction may be molded with a recess to be received in a slot in a support means or panel **266** to provide adequate support for the squeeze bulb. The squeeze bulb construction is molded with an integral tubular portion or tube **274** connected with the nipple **262** on the carburetor.

The foregoing described arrangement provides a priming means for positively injecting fuel under pressure into the mixing passage preparatory to starting the engine. When the engine is not in operation, the fuel inlet valve **86** in the carburetor, shown in FIGURE 7, is held in closed position under the pressure of the expansive coil spring **118**. If the engine has been in use, fuel is contained in the fuel chamber **52**. When the operator desires to start the engine, the throttle valve **34** is opened and the operator collapses the squeeze bulb or bulbous element **268**, either by squeezing pressure or by forwardly exerted pressure against the semispherical region of the bulb.

This action injects air pressure from the squeeze bulb into the fuel in the chamber **52**. The inlet valve **86** is closed and, as the fuel chamber is unvented, the increase in pressure on the fuel in the chamber ejects the fuel from either the primary or the secondary orifices or both into the mixing passage. The operator may collapse the squeeze bulb several times prior to starting the engine depending upon the ambient temperature conditions. If the temperatures are low, then repeated collapsing of the squeeze bulb may be required to deliver sufficient fuel to provide an enriched mixture for engine starting.

When the operator has completed the step of injecting fuel under pressure into the mixing passage, the engine is started in the usual manner. When pressure on the squeeze bulb is removed, the bulb returns to its normal expanded condition, a conventional characteristic of squeeze bulb construction, setting up a reduced pressure in the fuel chamber **52** which causes the diaphragm **54** to be elevated, as viewed in FIGURE 7.

This movement of the diaphragm moves the lever **96** in a counterclockwise direction, compressing the spring **118**, and opening the inlet valve **86** to effect flow of fuel into the chamber **52**. Upon subsequent collapsing of the squeeze bulb **268**, the fuel inlet valve **86** is closed by the spring **118** and pressure developed in the fuel chamber **52** positively ejects fuel into the mixing passage. The fuel is replaced by fuel flow through the inlet port from the supply during expanding movement of the squeeze bulb **268** to its normal position.

By this method, the mixing passage is provided with fuel to form an enriched mixture suitable for starting the engine prior to cranking operation of the engine. After several priming operations, any air in the squeeze bulb **268** is gradually replaced with fuel from the fuel chamber and thereafter the collapsing of the squeeze bulb **268** by manual pressure acts on liquid fuel only to effect ejection of liquid fuel into the mixing passage.

The ball check valve **126**, shown in FIGURE 7, performs an important function during manipulation of the squeeze bulb **268**. During return movement of the collapsed squeeze bulb to its normal expanded condition, the check ball **126** closes the main orifice passage **128** to prevent back bleeding of air from the mixing passage into the fuel chamber so that reduced pressure is established in the fuel chamber to cause the diaphragm **54** to open the inlet valve **86** to valve in fuel.

Ordinarily it is found that the secondary orifices **156** and **158** are of such small size that back bleeding of air through these orifices does not appreciably affect the pressures developed by the operation of the squeeze bulb **268**. Another force of air impeding media is present

which tends to prevent back bleeding of air through the secondary orifices during operation of the squeeze bulb. The needle valve **166** extending into the restriction **168**, shown in FIGURE 12, provides a very thin annular space around the needle valve. The liquid fuel in this annular space tends to form a capillary seal by capillary action, such method and arrangement being of a character described and claimed in Phillips Patent 2,841,372.

Another form of squeeze bulb or primer construction is shown in FIGURE 14. In this form a fitting **280** has a shank portion **282** extending through an opening in a support means or panel **284**, the shank means **282** being threaded to accommodate a securing nut **286** which is drawn up in the position shown in FIGURE 14 to secure the fitting to the panel or support means **284**.

The shank portion **282** is integral with a nipple or spud portion **288**, the latter receiving the end region of a flexible tube **290** adapted to be connected to the nipple **262** on the carburetor, shown in FIGURES 6 and 13.

The fitting **280** is provided with a circular portion **292** fashioned with a circular groove **294**. A flexible squeeze bulb or hollow bulbous element **296** of generally semispherical shape has a terminus region or circular bead **298** engaging in the circular recess **294**. A metal snap ring **300** of conventional construction embraces the terminal region **298** of the squeeze bulb or bulbous element **296** to effect an air tight connection or seal between the squeeze bulb **296** and the portion **292** of the fitting **280**. The fitting is provided with a central passage **302** establishing communication between the interior of the squeeze bulb **296** and the flexible tube **290**.

The bulbous element or squeeze bulb **296** is of molded flexible synthetic rubber or plastic which has sufficient elastic characteristics, as is conventional with squeeze bulb constructions, to return to its normal expanded position shown in FIGURE 14 after it has been collapsed or squeezed by the operator to inject fuel from the fuel chamber **52** into the mixing passage **12** preparatory to starting the engine in order to provide an enriched mixture in the mixing passage **12** of the carburetor.

FIGURE 15 illustrates a modified form of bulbous element or squeeze bulb construction. In this form a fitting **306** is fashioned with a hollow shank portion **308** projecting through an opening in a support means or panel **310**, a portion of the shank being threaded to accommodate the securing nut **312** for holding the fitting in assembled relation with the panel **310**. The fitting has a nipple portion **314** adapted to receive the end of a flexible tube **316** adapted to be connected with the nipple **262** shown in FIGURES 6 and 13.

An enlarged circular portion **318** of the fitting **306** is fashioned with a circular groove or recess **320**, the recess being of generally dove-tail shape in cross section. In this form, the bulbous element **322** of a semispherical hollow shape and of synthetic rubber or suitable flexible plastic is molded with a terminal portion **324** filling the dove-tail shaped groove **320**, thus securing the bulbous element or squeeze bulb **322** permanently to the fitting **306**. The operation of the squeeze bulb or bulbous element **322** is the same as in forms of the invention shown in FIGURES 13 and 14.

FIGURE 16 illustrates another form of primer construction of the invention. In this form the carburetor body **10***a* is integrally formed with a laterally extending cylindrically shaped boss portion **330** fashioned with a circular cylindrical bore **332** extending partially through the boss **330**. Slidably fitted in the cylindrical bore **332** is a plunger or member **334** which may be of semi-hard synthetic rubber or molded plastic or other suitable material resistant to deterioration by hydrocarbon fuels.

The plunger or piston **334** may be provided with a peripheral recess accommodating an O-ring **336** engaging the interior wall of the bore to effect a seal between the plunger and the wall of the cylinder.

Disposed within the cylinder **332** is an expansive coil spring **338**, one end of which is bottomed or seated in a counter bore **340**, the other end engaging the plunger **334** to bias the plunger to the normal retracted position shown in FIGURE 16. The cylindrical bore **332** is in communication with a fuel chamber **52**, shown in FIGURE 13, by a passage or duct **342**. A rod **344** is secured to the plunger **334**, the rod extending through an opening in a panel or support means **346**, the distal end of the rod being provided with a manipulating button **348** to enable the operator to reciprocate the plunger **334** in the cylinder **332**.

A washer **350** surrounds the rod at a region spaced from the panel **346** and is secured to the rod. A comparatively weak expansive coil spring **354** is disposed between the abutment or washer **350** and a grommet **356** mounted in an opening in a panel **346**, the spring **354** serving to resiliently position the plunger **334** normally at one end of the cylinder **332** in the position shown in FIGURE 16.

In the operation of the construction shown in FIGURE 16, the operator, preparatory to starting the engine, reciprocates the rod **344** through the medium of the grip member or finger button **348** one or more times to extrude or project liquid fuel under pressure from the chamber **52** into the mixing passage on each inward or pressure stroke of the plunger **334** and, upon return stroke of the plunger under the expansive pressure of the spring **338**, fuel is valved in to the fuel chamber **52** past the inlet valve **86**, shown in FIGURE 7, under the influence of reduced pressure temporarily developed in the fuel chamber by retraction of the plunger **334**.

In the several forms of primer construction illustrated in FIGURES 1 and 13 through 16, a variable volume chamber or hollow element is provided wherein the volume is varied by manual operation of an operator to positively eject or deliver liquid fuel from the fuel chamber **52** into the mixing passage for engine starting purposes.

In most installations or uses of the carburetor, the secondary orifices **156** and **158** are of very small size, for example a number seventy drill, being a diameter of 28 thousandths of an inch, or orifices of smaller size may be employed for delivering fuel into the mixing passage for engine idling and low speed operation.

Where secondary orifices of larger diameters are desired for engine idling and low speed operation augmenting the tendency for air to feed back through the orifices into the fuel chamber **52** during operation of the priming means, a check valve member may be utilized in the secondary fuel delivery system to prevent any back bleeding.

FIGURE 17 illustrates a valve construction of this character. FIGURE 17 is similar to FIGURE 12 and illustrates the supplemental chamber **154″**, an idling orifice **156″**, a manually operable valve **164″** having a needle valve portion **166″** cooperating with a restricted passage **360** for regulating or metering fuel flow to the secondary orifices. A bore **160″** containing the valve member **164″** is in communication with the fuel chamber **52** by a fuel passage **176″**. The restricted passage **360** opens into a small counter bore **362** in which is disposed a ball valve or check ball **366** of a size sufficient to close the restricted passage **360**. Disposed at the entrance of the counter bore **362** containing the ball valve **366** is a perforated member or screen **368** to maintain the ball valve **366** in the counter bore **362**. Thus, in installations where the capillary seal, provided by the fuel between the needle valve **166″** and the wall of the passage **360**, may be ineffective to prevent back bleeding of air into the fuel chamber **52** upon the expansion of the bulbous element shown in FIGURES 13, 14 and 15 or upon retraction of the plunger **334**, the ball valve **366** is caused by such reduced pressure to close the end of the restricted passage **360** to prevent air back bleeding through the passage **176″** into the fuel chanber **52**.

In this manner reduced pressure is developed upon expansion of the squeeze bulb or upon retraction of the priming element effective to open the inlet valve 86 and valve in fuel into the chamber 52, and fuel projected into the mixing passage by pressure exerted on the bulbous priming element or inward movement of the plunger 334 in the form shown in FIGURE 16.

One of the advantages in utilizing a flexible bulbous element such as the element shown in FIGURES 13, 14 and 15 is that the element may be positioned close to the carburetor or remotely therefrom as may be expedient without impairing the priming operation.

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, a carburetor having a mixing passage and an unvented fuel chamber, a throttle valve in the mixing passage, a flexible diaphragm forming a wall of the fuel chamber, a fuel inlet in the carburetor, an inlet valve for the inlet, motion transmitting means disposed between the inlet valve and the diaphragm whereby movement of the diaphragm controls the inlet valve to regulate flow of liquid fuel from a supply into the fuel chamber, passage means in communication with the fuel chamber for delivering fuel into the mixing passage, means including an auxiliary fuel storage member in communication with the fuel chamber manually actuable by an operator for forcing auxiliary fuel into the fuel chamber to eject fuel in the fuel chamber into the mixing passage through said passage means, and means in said passage means to impede air flow from the mixing passage into the fuel chamber so that reduced pressure is established in said fuel chamber and said diaphragm is caused to open said fuel inlet valve.

2. In combination, a carburetor having a mixing passage and an unvented fuel chamber, a throttle valve in the mixing passage, a flexible diaphragm forming a wall of the fuel chamber, a fuel inlet in the carburetor, an inlet valve for the inlet, motion transmitting means disposed between the inlet valve and the diaphragm whereby movement of the diaphragm controls the inlet valve to regulate flow of liquid fuel from a supply into the fuel chamber, passage means in communication with the fuel chamber for delivering fuel into the mixing passage, an auxiliary fuel storage squeeze bulb in communication with the fuel chamber manually actuable by an operator for forcing auxiliary fuel into the fuel chamber to eject fuel in the fuel chamber into the mixing passage through said passage means, and check valve means in said passage means to impede air flow from the mixing passage into the fuel chamber so that reduced pressure is established in said fuel chamber and said diaphragm is caused to open said fuel inlet valve.

3. A fuel feed system including a carburetor for use with an internal combustion engine, said carburetor having a body provided with a mixing passage and a recess, a throttle valve in the mixing passage, a flexible diaphragm extending across the recess forming therewith an unvented fuel chamber, fuel passage means for conveying fuel from the chamber into the mixing passage, a fuel inlet in the body adapted to receive liquid fuel from a supply, a valve for said inlet, means actuated by the diaphragm influencing the relative position of the inlet valve to control fuel flow into the fuel chamber, variable volume means including an auxiliary fuel storage member in communication with the fuel chamber, said variable volume means being manipulated by an operator to force the auxiliary fuel into the fuel chamber to eject fuel in the fuel chamber through said fuel passage means into the mixing passage, and check valve means in said fuel passage means to impede back bleeding of air into the fuel chamber so that reduced pressure is established in said fuel chamber and said diaphragm is caused to open said fuel inlet valve.

4. Apparatus of the character disclosed, in combination, a carburetor having a body member, a mixing passage in the body member, a throttle valve in the mixing passage, a recess in the body member, a flexible impervious diaphragm extending across the recess and forming therewith an unvented fuel chamber, a fuel inlet in the body member arranged to receive liquid fuel from a supply, a valve for said inlet, primary and secondary fuel delivery orifices opening into the mixing passage, means communicating movement of the diaphragm to the inlet valve to regulate fuel flow from the fuel chamber, fuel passage means in said body member for conveying fuel from the fuel chamber to the primary and secondary fuel delivery orifices, a pulse passage in said body member opening into the fuel chamber, an auxiliary fuel storage member connected to said pulse passage including manually operable pressure pulse establishing means for producing pressure pulses of fuel in the fuel chamber to eject fuel in the fuel chamber into the mixing passage for engine priming purposes, check valve means in said fuel passage means to impede air flow from the mixing passage into the fuel chamber so that reduced pressure is established in said fuel chamber and said diaphragm is caused to open said fuel inlet valve.

5. Apparatus of the character disclosed, in combination, a carburetor having a body member, a mixing passage in the body member, a throttle valve in the mixing passage, a recess in the body member, a flexible impervious diaphragm extending across the recess and forming therewith an unvented fuel chamber, a fuel inlet in the body member arranged to receive liquid fuel from a supply, a valve for said inlet, primary and secondary fuel delivery orifices opening into the mixing passage, means communicating movement of the diaphragm to the inlet valve to regulate fuel flow into the fuel chamber, fuel passage means in said body member for conveying fuel from the fuel chamber to the primary and secondary fuel delivery orifices, tubular means in communication with the fuel chamber, auxiliary fuel storage means associated with the tubular means actuable by the operator for successively forcing auxiliary fuel in the fuel chamber to eject successive increments of fuel in the chamber through the orifices into the mixing passage for engine priming purposes, check valve means in said fuel passage means, to impede air flow from the mixing passage into the fuel chamber so that reduced pressure is established in said fuel chamber and said diaphragm is caused to open said inlet valve, and means associated with said auxiliary fuel storage means including a piston and cylinder.

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