

- [54] **FUEL FEED AND CHARGE FORMING
METHOD AND APPARATUS**
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Related U.S. Application Data

- [63] Continuation of Ser. No. 14,781, Feb. 27, 1970, abandoned, which is a continuation of Ser. No. 742,679, July 5, 1968, abandoned.

- [52] U.S. Cl..... 261/35, 261/78 R, 261/69 A,
261/DIG. 68

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

- [58] **Field of Search**..... 261/69 A, DIG. 68,
261/37, 41, 78 R; 123/DIG. 6, 73 R, 139.8 AH

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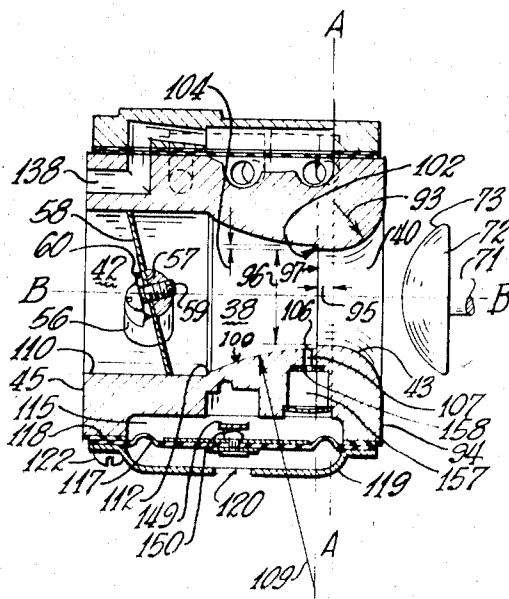
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[57]

ABSTRACT

The disclosure embraces a fuel feed and charge forming method and apparatus wherein the apparatus is of comparatively small size particularly for use with chain saws and other motor driven tools to effect the reduction in weight. The charge forming apparatus embodies a Venturi construction of modified shape, providing a method of operation wherein high capacity delivery of fuel and air mixture to the engine is attained, the mounting means for the charge forming apparatus being of a character to reduce the transmission of engine heat to the apparatus.

5 Claims, 9 Drawing Figures



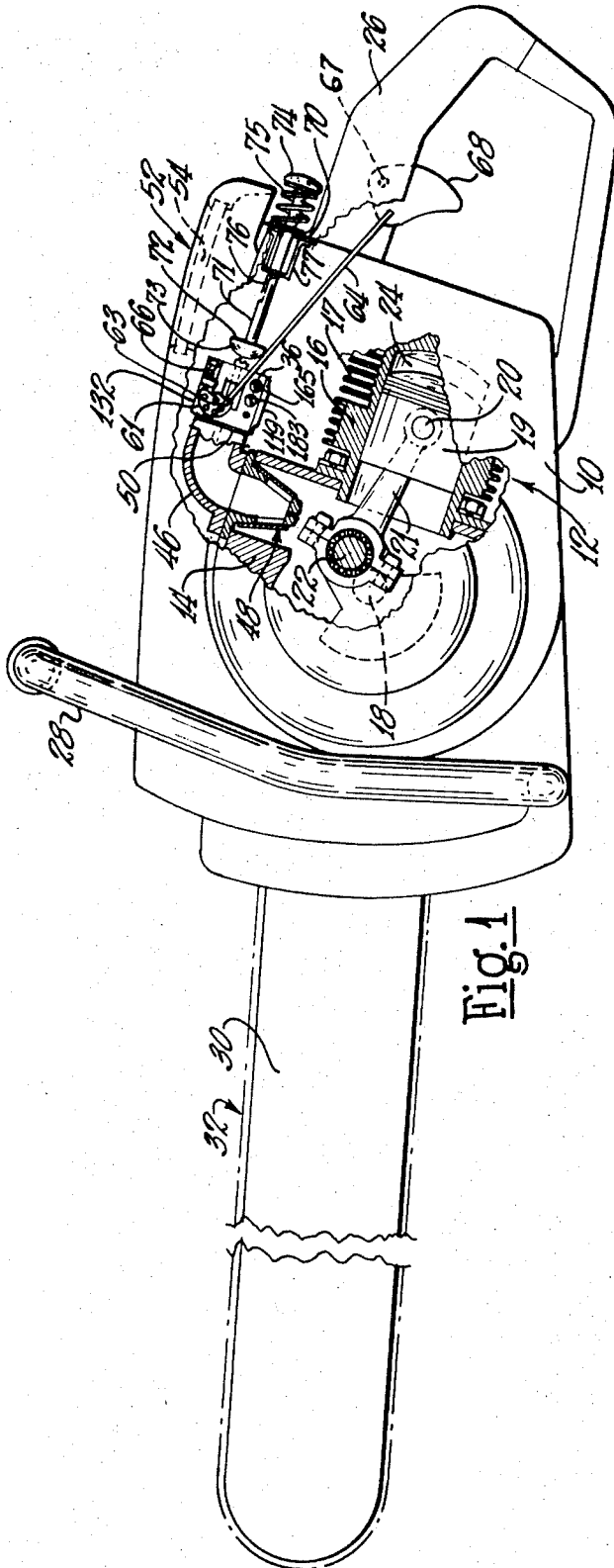


Fig. 1

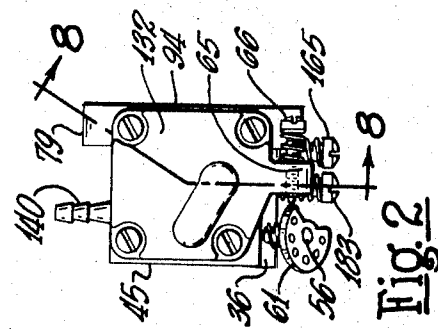


Fig. 2

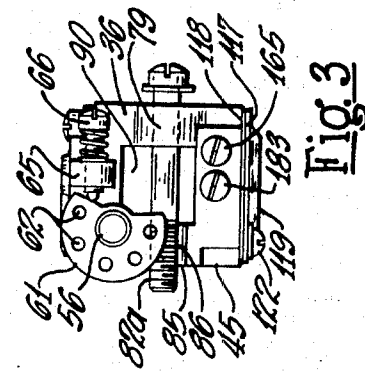


Fig. 3

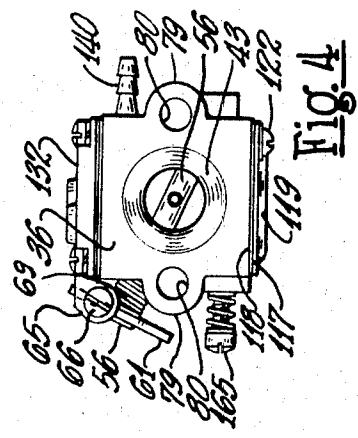
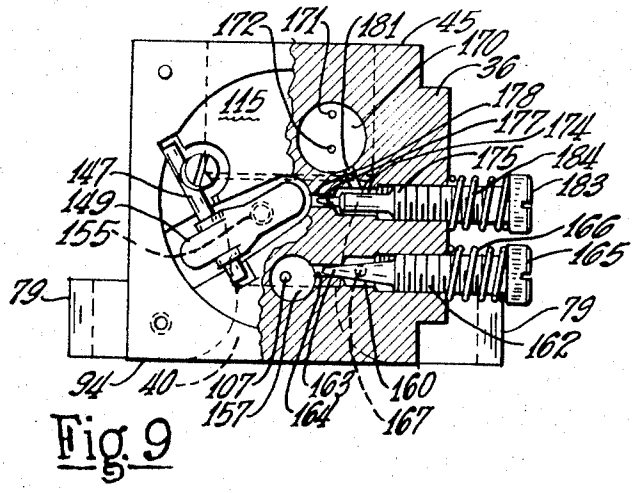
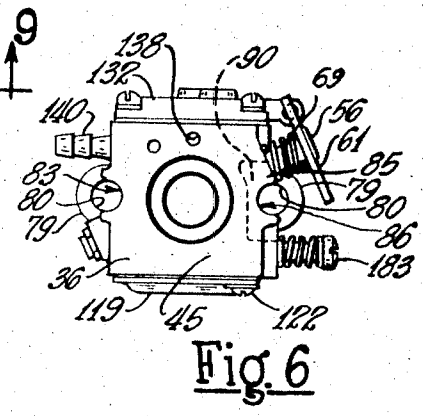
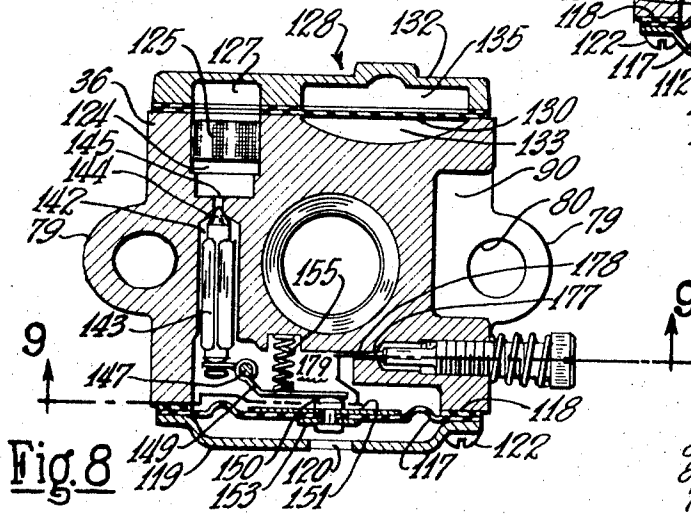
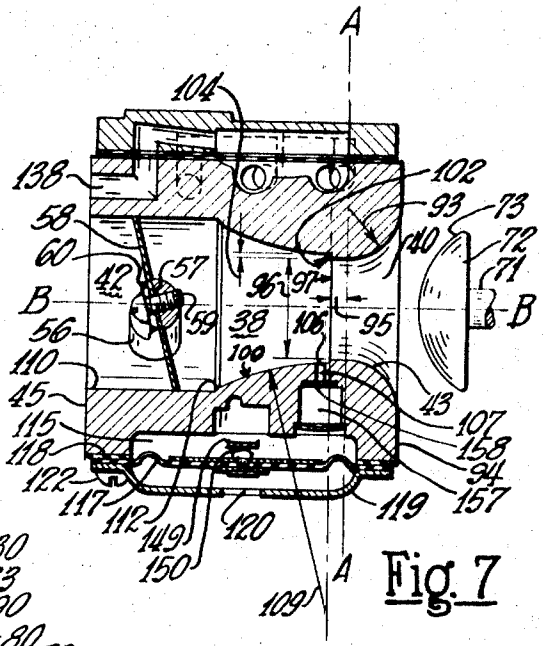
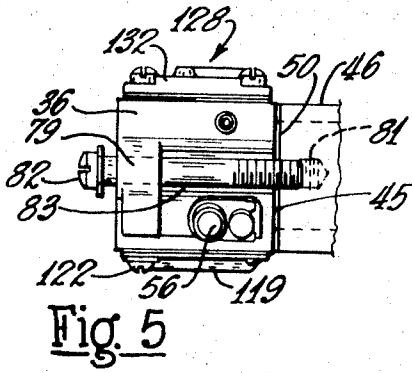


Fig. 4



FUEL FEED AND CHARGE FORMING METHOD AND APPARATUS

This is a continuation of copending application, Ser. No. 14,781, filed Feb. 27, 1970, now abandoned, which is a continuation of Ser. No. 742,679, filed July 5, 1968 and now abandoned.

The invention relates to a fuel feed and charge forming method and apparatus for supplying a fuel and air mixture to internal combustion engines of the two-cycle type of a character employed for driving chain saws, lawnmowers, outboard marine engines and the like wherein the fuel feed and charge forming apparatus involves a diaphragm type carburetor and diaphragm fuel pump which are combined in a unitary construction.

Heretofore carburetors of the diaphragm type have been utilized, particularly for use on chain saws, and the carburetor body construction has been fashioned of a size to provide a mixing passage of cross sectional area to accommodate air and fuel mixture in volumes adequate to operate engines of low horsepower of the two-cycle type. Carburetor and fuel pump combinations have been devised with a view effecting reduction in weight of the carburetor construction particularly for use on chain saws because it is desirable insofar as possible to reduce the weight of a portable chain saw. An example of this type of carburetor is disclosed and claimed in Phillips' U.S. Pat. No. 3,275,306. A further factor in the construction of a carburetor and fuel pump combination particularly for use with a chain saw is the limited space available for installation of the carburetor and fuel feed apparatus. The carburetor shown in U.S. Pat. No. 3,275,306 has been commercially produced and used extensively with chain saw engines. The size of the carburetors made according to the disclosure of this patent is about $1\frac{1}{2} \times 1\frac{1}{8} \times 1\frac{1}{4}$ inches which, at the time of the development of the invention disclosed in U.S. Pat. No. 3,275,306 was considered to be a very compact construction, the combined fuel pump and carburetor of the character shown in the patent weighing about 5 ounces.

The present invention embraces a combined carburetor and fuel pump construction which is very small and compact and yet provides a configuration of mixing passage facilitating a high volume flow of air and fuel mixture adequate to operate chain saw engines or engines of a similar character efficiently at all speeds.

An object of the invention resides in a method of forming a combustible fuel and air mixture and obtaining a high volume flow thereof by establishing a region of reduced pressure in the mixing passage effective to increase the mixture flow as compared with a conventional configuration of mixing passage and to provide a more homogeneous mixture of fuel and air for the engine.

Another object of the invention resides in the provision of a carburetor and fuel pump construction which is of reduced size and wherein the arrangement for mounting the construction is of a character to minimize the transmission or conduction of engine heat to the carburetor body thereby minimizing the tendency for the liquid fuel in the fuel chamber of the carburetor to be volatilized.

The invention has for an object the provision of a comparatively small compact carburetor fashioned with a mixing passage embodying a novel form of venturi-like shape which promotes an increase in volumet-

ric air and mixture flow capacity with improved distribution of the fuel in the air stream in a mixing passage of substantially reduced size.

Another object of the invention resides in a carburetor construction having a venturi-like configuration at the air inlet region, and a member exteriorly of the carburetor body movable to a position to obstruct the air inlet region for use in engine starting operations.

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:

FIG. 1 is a side elevational view, partly in section, of a chain saw construction powered by a two-cycle engine illustrating one form of the charge forming and fuel feed apparatus of the invention associated therewith;

FIG. 2 is a top plan view of the combined carburetor and fuel pump construction embodying the invention;

FIG. 3 is a view of one side of the construction shown in FIG. 2;

FIG. 4 is a view of the air inlet end of the construction;

FIG. 5 is an elevational view of the opposite side of the carburetor and fuel pump construction;

FIG. 6 is a view of the opposite or mixture outlet end of the carburetor;

FIG. 7 is an enlarged longitudinal sectional view through the carburetor on the longitudinal axis of the mixing passage;

FIG. 8 is an enlarged transverse sectional view, the section being taken substantially on the line 8--8 of FIG. 2, and

FIG. 9 is an enlarged sectional view taken substantially on the line 9--9 of FIG. 8.

The diaphragm carburetor and pump construction embodying the invention is of a character particularly usable with low horsepower two cycle engines and more especially engines employed for powering chain saws, lawnmowers, portable drills and wherever a compact lightweight carburetor and pump construction is desired.

The carburetor and fuel pump construction has particular utility for use with chain saws where it is imperative to reduce weight, the carburetor construction being of a character which is operable in all angular positions, including inverted position, a necessary requisite for chain saw operation. FIGS. 2 through 6 illustrate the carburetor and fuel pump combination of actual size employed with two-cycle chain saw engines.

Referring to the drawings in detail and initially to FIG. 1, there is illustrated an internal combustion engine driven chain saw of conventional construction embodying a form of charge forming and fuel feed apparatus of the invention. The saw construction is inclusive of a housing 10 enclosing frame means (not shown) and an engine 12 of the reciprocating piston two-cycle type. The engine 12 includes a crankcase 14 and a cylinder 16, the walls of the cylinder being fashioned with cooling fins 17.

The engine embodies a conventional crankshaft 18 journaled in the crankcase 14 and a piston 19 recipro-

cable in the cylinder 16, the piston having a piston pin 20 connected by a connecting rod 21 with a crankpin 22 of the crankshaft 18.

The head of the cylinder is equipped with a spark plug (not shown) for igniting the fuel and air mixture in a combustion chamber or region 24 above the piston 19.

The engine is provided with a port or passage (not shown) for conveying fuel and air mixture from the crankcase 14 into the combustion chamber 24 in a manner conventional in two cycle engines. The cylinder is provided with an exhaust port (not shown) of conventional type through which exhaust gases are exited from the cylinder after each power stroke of the piston.

The chain saw construction is equipped with handles or hand grip members 26 and 28 to facilitate manipulation of the chain saw by an operator. Secured to the frame construction and extending forwardly is a plate-like member 30 which provides a support and guide means for an endless or chain type saw 32, illustrated schematically in FIG. 1, the forward end of the member 30 journally supporting a conventional sprocket (not shown) engaging and guiding the chain saw.

The saw chain engages a driving sprocket (not shown) driven by the engine crankshaft 18 through an automatic clutch mechanism (not shown). The automatic clutch mechanism is of a conventional type which automatically establishes an operative drive connection between the crankshaft 18 and the saw chain drive sprocket at normal or high engine speeds, the clutch mechanism automatically disconnecting the drive connection with the crankshaft 18 when the engine speed is reduced to idling speed. The construction and operation of the chain saw are conventional.

The fuel feed system and charge forming apparatus includes diaphragm carburetor and diaphragm fuel pump construction shown in FIGS. 2 through 9. The carburetor component is inclusive of a carburetor body 36, which is preferably of die cast metal, the actual size of the body being illustrated in FIGS. 2 through 6. The body is of generally cubical shape and is fashioned with an air and fuel mixing passage 38, shown in FIG. 7, the passage having an air inlet region 40 and a mixture outlet region 42.

The mixing passage includes a modified venturi-shaped configuration which will be hereinafter described in detail, the air inlet region being defined by a curved configuration 43. The mixture outlet end of the carburetor has a uniplanar mounting surface 45 which, as shown in FIGS. 1 and 5, is adapted for attachment to an intake manifold 46 for conveying fuel and air mixture into the engine crankcase 14. As shown in FIG. 1, a conventional reed valve construction 48 controls delivery of mixture into the crankcase. A gasket 50 is disposed between the carburetor body and the intake manifold 46.

The housing construction 10 includes a cover portion 52 having an air inlet passage in which is disposed an air filter 54 to filter air admitted to the air inlet 40 of the carburetor. Journalled in bores in the wall defining the mixture outlet region 42 of the mixing passage is a throttle shaft 56. The region of the throttle shaft within the mixture outlet 42 has a flat surface 57 on which is mounted a disc-type throttle valve 58.

The throttle shaft 56 is provided with a central threaded bore to receive a screw 59 securing the throt-

tle valve 58 to the shaft 56, a washer 60 being disposed between the head of the screw 59 and the throttle valve 58.

A portion of the throttle shaft exteriorly of the carburetor body is equipped with a plate 61 having openings 62 for accommodating an end 63 of a throttle operating rod 64, shown in FIG. 1. A threaded boss 65 on a pump cover plate 132 supports a screw 66 engageable with the plate 61 for adjusting the engine idling position of the throttle valve 58. Pivotaly mounted on the hand grip portion 26 is a pin 67 pivotaly supporting a throttle valve actuating member or trigger 68 connected with the rod 64 whereby the operator manipulates the throttle valve through pivotal movement of the member 68. A spring 69 surrounding the throttle shaft 56 normally biases the member 61 in a direction to maintain the throttle valve 58 in near closed or engine idling position.

The curved surface 43 defining the air inlet 40 of the mixing passage is in the shape of a partial section of a torus, which configuration facilitates smooth flow of air into the mixing passage, the curved surface 43 being also referred to as a curved surface of revolution. Means is provided independent of the carburetor for temporarily obstructing the air inlet 40 for engine starting purposes. As shown in FIG. 1, a wall 70 of the chain saw housing 10 is fashioned with an opening slidably accommodating a rod 71 having a partially spherically shaped or dome-like closure member 72 mounted on the end of the rod adjacent the air inlet region 40.

The spherically shaped surface 73 of the member 72 is adapted, when engaged with the surface 43 of the air inlet region to close or obstruct the air inlet region as a choke means for engine starting purposes. The rod 71 extends through the opening in the housing wall 70 and through an opening in a guide member or bracket 77 and has a button or enlarged portion 74 provided on the end thereof.

Disposed between the button member 74 and the wall 70 is an expansive coil spring 75 which normally biases the rod in a direction to move the air inlet closure member 72 away from the inlet region whereby the air inlet region is normally open. A pin 76 extends through a transverse opening in the rod 71 and forms an abutment engaging the bracket 77 to limit the extent of movement of the closure member 72 in a direction away from the air inlet region of the carburetor. The member 72 may be a flat plate and, if desired, may be slidable transversely for opening and closing the air inlet region in a well known conventional manner.

The mounting means for securing the carburetor to the mixture manifold 46 is of a character minimizing the transmission or conduction of heat from the engine crankcase wall to the carburetor body. Fashioned on the exterior of the carburetor body 36 at the end of the carburetor adjacent the air inlet region 40 are laterally projecting boss portions 79 which are provided with bores 80, the manifold 46 being provided with threaded bores 81 to receive the threaded portions of the securing or mounting bolts 82 and 82a.

As shown in FIGS. 3 and 5, the boss portions 79 are of a length preferably slightly less than one-third of the length of the carburetor body, viz, the boss portions being of a length of about five-sixteenths of an inch. Fashioned in one exterior side wall of the body is a semicylindrical recess 83 extending from the boss 79 to the mounting face 45 of the carburetor. The radius of

curvature of the semicylindrical recess 83 is substantially the same as the radius of the bores 80 so as to accommodate the bolt 82 in the manner illustrated in FIG. 5.

The opposite side of the carburetor body is fashioned with a portion 85 provided with a semicylindrical recess 86 of the same radius of curvature as that of the curved surface 80 to accommodate the other mounting bolt 82a. As shown in FIG. 3, the boss portion 85 containing the semicylindrical recess 86 is of a length substantially equal to the length of a boss 79. As shown in FIGS. 3 and 6, the carburetor body 36 is fashioned with a generally rectangular recess 90 to effect reduction in weight of the carburetor body and to further reduce transmission of engine heat to the body from the bolt 82a.

By providing the semicylindrical recess 83 on one side of the carburetor body and a semicylindrical recess 86 and the rectangular recess 90 on the opposite side of the carburetor body, there is a minimum area of engagement of the mounting bolts 82 and 82a with the carburetor body and the exposure of substantial portions of the bolts 82 and 82a to the ambient air effect a cooling of the bolts resulting in a reduction in heat transferred or conducted to the carburetor body from the engine.

A feature of the carburetor involves a shape or configuration for the mixing passage which, although resembling generally a venturi, involves a special or modified configuration which, among other advantages, provides for an increased fluid flow through a restricted region of the mixing passage of reduced diameter, this feature enabling a substantial reduction in size and weight of the carburetor and yet attain increased volumetric or air flow efficiency.

The actual size of the carburetor body as shown in FIGS. 2 through 6, is approximately of the following dimensions: 1½ inches in length, 1½ inches in height excluding the thickness of the pump plate 132 and the diaphragm cover 119, and excluding protruding portions of the bosses 79, is about 1-5/16 inches in width. The particular configuration or shape of the mixing passage is illustrated in FIG. 7. The curvature of the surface 43 defining the air inlet 40 is derived as a surface of revolution of a radius 93 about a circular line in a plane A—A normal to the longitudinal axis B—B of the mixing passage.

The terminus of the curved surface 43 converges or blends into the flat or planar surface 94 at the air inlet end of the carburetor. This feature enables the smooth flow of air into the air inlet region 40, this being another factor increasing the air flow efficiency or capacity of the mixing passage. The diameter of the most restricted region or choke band 95 of the venturi-like shape is indicated by dimension 96 which, in the carburetor illustrated, is approximately three-eighths of an inch.

It is to be understood that while the diameter of the restricted zone 95 in the mixing passage illustrated is about three-eighths of an inch which is the size required to accommodate air flow or volume of air for a particular size engine, the restricted band 95 may be of slightly lesser or greater dimension to accommodate engines of different sizes within the limitations of the size of the carburetor. Hence, the diameter 96 of the restricted zone 95 may be within a range of five-sixteenths inch and seven-sixteenths inch without in-

creasing the over-all dimensions of the carburetor body.

In the embodiment disclosed the choke band or restricted region 95 is about one-sixteenth inch in width but may be of slightly greater width, the band terminating at the traverse plane 97. In the embodiment illustrated, the downstream curvature 100 is generated as a surface of revolution of a radius 109 about a circle in the terminal plane 97 defining the length of the choke band 95 and is a partial section of a torus in shape. The downstream terminus of curvature 100 is joined with the cylindrical surface 110 of the mixture outlet region 42 by an angular or frusto-conical surface 112, the angularity of taper of the surface 112 being about 45° with respect to the longitudinal axis B—B of the mixing passage. The small diameter of the curvature 100 at the plane 97 defining the length of the choke band is of slightly greater diameter than the diameter 96 of the choke band.

This increase in diameter provides an annular recess or space adjacent the terminus 97 of the choke band 95 of a depth or thickness indicated at 104 of from five-thousandths of an inch to eight-thousandths of an inch and preferably about six-thousandths of an inch.

Thus, the annular enlargement provided at the region or zone of intersection of the curvature 100 with the terminal plane 97 of the choke band 95 provides an annular region of reduced pressure, and the main orifice 106 provided by a passage 107 in the carburetor fuel channel system, opens into this annular region of reduced pressure.

The feature of delivering fuel for normal and high speed engine operation through the main orifice 106 into the annular or circular zone 102 of reduced pressure adjacent the terminal plane 97 of the choke band promotes a more homogeneous mixture of fuel and air. The annular region 102 of reduced pressure influences the fuel delivered from the orifice 106 to migrate or move circularly in the annular zone 102 of reduced pressure thereby minimizing the tendency for the fuel to be delivered into the central region or core of the air stream moving through the area defined by the choke band.

It is found that this tendency for the fuel to migrate or spread around the circular zone 102 of reduced pressure fosters improved mixing of the liquid fuel with the air flowing through the mixing passage so that a more homogeneous combustible mixture is attained. This factor increases the efficiency of the engine through improved homogeneity of the mixture by reason of the method of delivering the fuel from the orifice 106 into an annular reduced pressure zone in the mixing passage.

An important factor providing increased efficiency of mixture flow through the mixing passage resides in the downstream curvature 100 of the passage wall. By fashioning the surface 100 as a surface of revolution about a circle in the plane 97, the fuel and air mixture tends to flow smoothly along and in contact with the curved surface 100 without turbulence as the mixture expands after moving through the restricted zone 95.

In a conventional venturi shape, the surface downstream of the restricted zone or choke band is of frusto-conical shape providing a progressive increase in cross section of linear character. The curved surface of revolution 100 provides a nonlinear or accelerated increase in cross sectional area at succeeding equal increments

of distance axially of the mixing passage downstream of the ledge 102. This facilitates progressively accelerated increase in expansion of the fuel and air mixture providing improved flow efficiency and increased delivery of mixture into the engine.

In the carburetor arrangement of the invention, it is imperative that the main fuel delivery orifice 106 open into the mixing passage at a region downstream of the terminal plane 97 of the choke band 95 and as close as practicable to said plane in order to obtain the advantage of the reduced pressure zone tending to spread the fuel in the air stream moving through the choke band 95.

The carburetor of the invention embodies a main or primary fuel delivery system for normal and high speed engine operation and an engine idling and low speed secondary fuel delivery system which are similar to the systems disclosed in Phillips' U.S. Pat. No. 3,275,306. The carburetor body is fashioned with a circular recess or fuel chamber 115, shown in FIGS. 7, 8 and 9, a flexible member or diaphragm 117 extending across the recess forming one wall of the fuel chamber 115. A gasket 118 is disposed between the periphery of the diaphragm and the planar surface of a portion of the carburetor body defining the fuel chamber 115.

A cover member 119 is disposed beneath the diaphragm and has a central depressed region to facilitate flexing of the diaphragm, the cover 119 being provided with a vent opening 120.

Screws 122 extend through registering openings in the cover 119, diaphragm 117 and gasket 118 and are threaded into openings in the body 36 to secure these parts in the positions shown in FIGS. 7 and 8. The diaphragm 117 is adapted to be flexed or actuated by reduced pressure or engine aspiration in the mixing passage 38 for controlling delivery of liquid fuel into the unvented fuel chamber 115.

The body 36 is fashioned with a fuel inlet passage 124 in which is disposed a fuel filter or screen 125. The duct or passage 124 is in communication with a fuel delivery channel 127 of a fuel pump construction 128 of the character shown in Phillips' U.S. Pat. No. 3,275,306. The pump includes a pumping diaphragm 130, a cover member or plate 132, a fuel chamber 133 formed in the body 36 at one side of the diaphragm and a pulse or pumping chamber 135 formed in the cover plate 132.

The pulse chamber 135 is connected with a pulse channel 138 which opens at the mounting face 45 and registers with an opening in the crankcase wall whereby varying fluid pressure in the engine crankcase flexes or vibrates the pumping diaphragm 130 to pump fuel from a supply to the carburetor. A nipple 140, extending into an opening in the carburetor body, is connected by a tube (not shown) with a fuel tank. The pumping diaphragm 130 is fashioned with flap valves (not shown) cooperating with ports in communication with the fuel chamber 133 whereby fuel is pumped under comparatively low pressure to the inlet passage 124 in the carburetor.

As shown in FIG. 8, a bore 142 in the carburetor body accommodates a valve body or member 143 slidably disposed therein. The valve body 143 is of polygonal cross section and is fashioned with a needle valve portion 144 cooperating with a port 145 opening into the inlet duct 124.

Fulcrumed on a pin 147 and disposed in the fuel chamber 115 is a lever 149, the long arm of the lever

engaging a button-like member 150 secured to the central region of the diaphragm and extending through reinforcing discs 151 and 153.

The short arm of the lever is engaged with the lower end of the valve body 143. An expansive coil spring 155 engages the long arm of the lever adjacent the fulcrum, the spring normally biasing the valve 144 to a position closing the port 145. Through this arrangement the valve body 143 is responsive to the flexing movements of the diaphragm 117.

The main or primary fuel delivery system is inclusive of the main orifice 106, being the outlet of passage 107, the latter being in communication with a well 157. Disposed between the passage 107 and the well 157 is a fuel wettable member 158, such as a fine mesh screen, whereby the liquid fuel adhering to the screen by capillary action forms a liquid or capillary seal to prevent back bleeding of air through the main orifice into the secondary fuel delivery system when the latter system is delivering fuel into the mixing passage. The principle of a capillary or liquid fuel seal for the prevention of back bleeding through the main orifice is described in Phillips' U.S. Pat. No. 2,841,372.

The capillary or liquid seal is readily broken or overcome upon increase in engine speed by reason of the increase in aspiration or reduced pressure in the mixing passage with the throttle open, thus reestablishing fuel delivery through the main orifice 106 for intermediate and high speed engine operation.

The body 36 is fashioned with a bore 160 having a threaded portion to receive a threaded body of an adjusting valve member 162, the member 162 having a needle valve portion 163 which extends into a restricted passage 164 opening into the well or recess 157.

The valve body 162 is provided with a knurled manipulating head 165, and a coil spring 166 between the head and the carburetor body providing friction to retain the valve body in adjusted position. The bore 160 is in communication with the fuel chamber 115 by a passage 167, shown in broken lines in FIG. 9. Fuel for normal and high speed engine operation flows from the diaphragm fuel chamber 115 through passage 167, bore 160, past the needle valve 163, through restriction 164 and well 157 for discharge through the main orifice 106 provided by the passage 107.

The secondary fuel delivery system for engine idling and low speed operation includes a supplemental chamber 170 which is in communication with the mixing passage 38 by way of an engine idling orifice 171 and a low speed orifice 172. The body 36 is fashioned with a bore 174 having a threaded portion to accommodate a threaded portion of a valve body 175. The valve body 175 has a tenon provided with a needle valve portion 177 extending into and cooperating with a restricted passage 178 which opens into a recess 179 of the fuel chamber 115.

The supplemental chamber 170 is connected with the bore 174 by a passage 181 shown in FIG. 9. The valve body 175 is fashioned with a knurled manipulating head 183, and a coil spring 184 is disposed between the head 183 and the carburetor body 36 providing friction for retaining the valve body 175 in adjusted position.

The operation of the carburetor is as follows: Assuming that the carburetor has been previously operated and the fuel chamber 115 is filled with liquid fuel which had been pumped from the supply tank by the dia-

phragm pump construction 128 to the region of the inlet valve 144. The pumping diaphragm is actuated by varying fluid pressure from the engine crankcase when the engine is cranked or started. In starting the engine, the operator exerts pressure on the button 74 on the rod 71 and thereby moves the partial spherically shaped member 72 into engagement with the curved surface 43 to substantially close the air inlet 40 of the mixing passage 38.

The engine is then cranked by the operator with the throttle valve 58 in partial or full open position. With the air inlet 40 substantially closed by the member 72, engine aspiration in the mixing passage is effective to aspirate fuel from the fuel chamber 115 past the needle valve 163 through the well 157 and passage 107, the fuel being discharged through the main orifice 106, thus starting the engine.

As soon as the engine is operating, the operator removes manual pressure from the button 74 and the spring 75 retracts the member 72 away from the surface 43 thereby opening the inlet 40.

In normal or high speed operation of the engine, the fuel aspirated into the mixing passage through the main orifice 106 enters the mixing passage at the annular region of reduced pressure provided at the region 102 adjacent the choke band 95 of the venturi-like configuration.

Through this method of delivering the fuel into an annular region of reduced pressure in the mixing passage, the fuel is more uniformly mixed with the air moving through the mixing passage to provide a homogeneous mixture of fuel and air. The aspiration in the mixing passage is influential through the main orifice passage 107, fuel well 157 and fuel channels 164, 160 and 167 to establish reduced pressure in the fuel chamber 115.

Reduced pressure established in the fuel chamber 115 flexes the diaphragm upwardly, as viewed in FIG. 8, swinging the lever 149 about the fulcrum 147 in a counterclockwise direction whereby the inlet valve 144 moves downwardly and opens the inlet port 145 to effect flow of fuel into the chamber 115 at the rate at which the fuel is aspirated into the mixing passage from the fuel chamber 115 through the main orifice 106. The rate of fuel delivery through the main orifice is regulated or controlled by the manually operated needle valve 163.

When the throttle valve 58 is in engine idling position, that is, in the position shown in FIG. 7, fuel for engine idling operation flows from the fuel chamber 115 through restricted passage 178, past the needle valve 177, through bore 174, passage 177 into the supplemental chamber 170 and is delivered through the engine idling orifice 171 at the downstream side of the throttle valve 58.

During idling operation of the engine the liquid fuel adhering to the member or screen 158 prevents the back bleeding of air from the mixing passage through the main orifice 106 and into the engine idling fuel system so as not to impair the delivery of fuel for engine idling purposes.

When the throttle valve 58 is partially opened, fuel flows from the supplemental chamber 170 through both the engine idling orifice 171 and the low speed orifice 172. The fuel for delivery through the secondary orifices 171 and 172 is regulated or controlled by adjustment of the needle valve 177.

The special configuration of mixing passage illustrated in FIG. 7 and hereinbefore described provides for increased flow of air and fuel to the engine whereby a smaller size mixing passage may be used than has heretofore been possible in carburetors of this general character.

It should be noted that the curvature 43 of the air inlet blends into the planar face 94 of the carburetor facilitating smooth flow of air through the air inlet 40. The provision of the annular zone 102 of reduced pressure adjacent the choke band 95 or zone of maximum restriction effects distribution of the fuel delivered through the main orifice 106 in an annular region so that the fuel is more thoroughly mixed with the air moving through the mixing passage to provide a homogeneous mixture thereby improving engine efficiency.

Another factor providing for high air flow movement through the mixing passage is that the mixing passage is of comparatively short length between the entrance face 94 and the mounting face 45. With this arrangement there is less frictional drag upon the air with a consequent increase in the air flow capacity of the mixing passage, this being another factor enabling the use of a mixing passage of reduced cross sectional dimensions capable of supplying adequate volume of mixture for all engine speeds.

The use of the comparatively short bosses 79 engaging the mounting bolts 82 provides clearance regions adjacent the mounting bolts for cooling the bolts and additionally reduces the transmission or conduction of heat from the engine crankcase to the carburetor body, thus minimizing the tendency for volatilizing the liquid fuel in the fuel chamber. The carburetor of actual size, as shown in FIGS. 2 through 6, according to the dimensions given herein weighs about 3 ounces.

The carburetor of the invention is of very small size and of much less weight than other diaphragm carburetors of comparable flow capacity and the method of mounting the carburetor reduces heat transfer to the carburetor body. The comparatively short mixing passage of the configuration hereinbefore described substantially reduces air friction or air drag with the consequent increase in flow capacity.

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.

We claim:

1. Charge forming apparatus for an internal combustion engine including, in combination, a substantially cubically shaped body provided with a mixing passage having an air inlet region and a mixture outlet region, a fuel chamber in the body, a flexible diaphragm forming a wall of the chamber, a fuel inlet in the body, a valve for the fuel inlet, control means for said fuel inlet valve including a lever actuated by movement of said diaphragm under the influence of reduced pressure in the mixing passage, a main orifice opening into the mixing passage, a throttle valve in the mixture outlet region of the mixing passage, an engine idling orifice opening into the mixing passage at the downstream side of the throttle valve, fuel channel means in said body for conveying liquid fuel from the fuel chamber to the orifices, said body having a planar mounting surface for mounting on an engine, a boss extending transversely from each side of the body at the end of the body adjacent

the air inlet region, each of the bosses having a bore accommodating a mounting bolt, said bosses being spaced from the planar mounting surface and of a length less than one-third the length of the body whereby to expose portions of the mounting bolts to the atmosphere for cooling the bolts.

2. Charge forming apparatus for an internal combustion engine including, in combination, a substantially cubically shaped body provided with a mixing passage having an air inlet region and a mixture outlet region, a fuel chamber in the body, a flexible diaphragm forming a wall of the fuel chamber, a fuel inlet passage in the cubically shaped body, an elongated valve member in said inlet passage longitudinally movable on an axis normal to the plane of the diaphragm, control means for said valve member including a lever actuated by movement of said diaphragm under the influence of reduced pressure in the mixing passage, a main orifice opening into the mixing passage, a throttle valve in the mixing passage, an engine idling orifice opening into the mixing passage at the downstream side of the throttle valve, fuel channel means in said body for conveying liquid fuel from the fuel chamber to the orifices, said body having a planar mounting surface for mounting on an engine, a boss extending transversely from each side of the body at the end of the body adjacent the air inlet region, each of the bosses having a bore accommodating a body mounting bolt, said bosses being spaced from the planar mounting surface to expose portions of the mounting bolts to the atmosphere for cooling the bolts, each side of the body having a recess of semicircular cross section between the adjacent boss and the mounting surface of the body accommodating a mounting bolt.

3. Charge forming apparatus including, in combination, a cubically shaped body provided with a mixing passage having an air inlet region, a fuel and air mixing zone and a mixture outlet region, a fuel chamber in the body, a flexible diaphragm forming a wall of the fuel chamber, a fuel inlet in the body, valve means for the fuel inlet, control means for said valve means including a lever actuated by movement of said diaphragm under the influence of reduced pressure in the mixing passage, a main orifice opening into the mixing passage, a throttle valve in the mixture outlet region of the mixing passage, an engine idling orifice opening into the mixing passage at the downstream side of the throttle valve, fuel channel means in said body for conveying liquid fuel from the fuel chamber to the orifices, said air inlet region being defined by a first curved surface of revolution, the inner circular terminus of said curved surface defining a circular zone of maximum restriction

in the mixing passage, a second curved surface of revolution having its small diameter adjacent the circular zone of restriction and defining a wall portion of a fuel and air mixing zone of the mixing passage, the small diameter of the second curved surface being of greater diameter than that of the circular zone of maximum restriction, said second curved surface of revolution being joined with a cylindrical surface of the mixing passage, said main orifice opening into the mixing passage adjacent the circular zone of maximum restriction.

4. The combination according to claim 3 wherein the circular zone of maximum restriction is of a diameter in a range of five-sixteenths inch and seven-sixteenths inch.

5. Charge forming apparatus including, in combination, a cubically shaped body provided with a mixing passage having an air inlet region and a mixture outlet region, said body having a planar mounting surface for mounting on an engine, a fuel chamber in the body, a flexible diaphragm forming a wall of the chamber, a fuel inlet in the body, valve means for the fuel inlet, control means for said valve means including a lever actuated by movement of said diaphragm under the influence of reduced pressure in the mixing passage, a main orifice opening into the mixing passage, a throttle valve in the mixture outlet region of the mixing passage, an engine idling orifice opening into the mixing passage at the downstream side of the throttle valve, fuel channel means in said body for conveying liquid fuel from the fuel chamber to the orifices, said air inlet region being defined by a curved surface of revolution, the inner circular terminus of said curved surface defining a circular zone of maximum restriction of the mixing passage, a second curved surface of revolution forming a wall portion of the mixing passage downstream of the air inlet region, the minimum diameter of the second curved surface of revolution being adjacent the inner terminus of the first curved surface, the largest diameter of the second curved surface being joined with a cylindrical surface of the mixing passage, said main orifice opening into the mixing passage at the region of minimum diameter of the second curved surface of revolution, a transversely extending mounting boss on each side of said body adjacent the air inlet region of the mixing passage, the bosses being about one-third the length of the body, each boss having a bore adapted to receive a bolt for mounting the body, each side of the body having a recess of semicircular cross section between the adjacent boss and the mounting surface of the body accommodating a mounting bolt.

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