Oct. 10, 1961 B. C. PHILLIPS 3,003,754

CHARGE FORMING APPARATUS

Filed Dec. 16, 1958 4 Sheets-Sheet 1

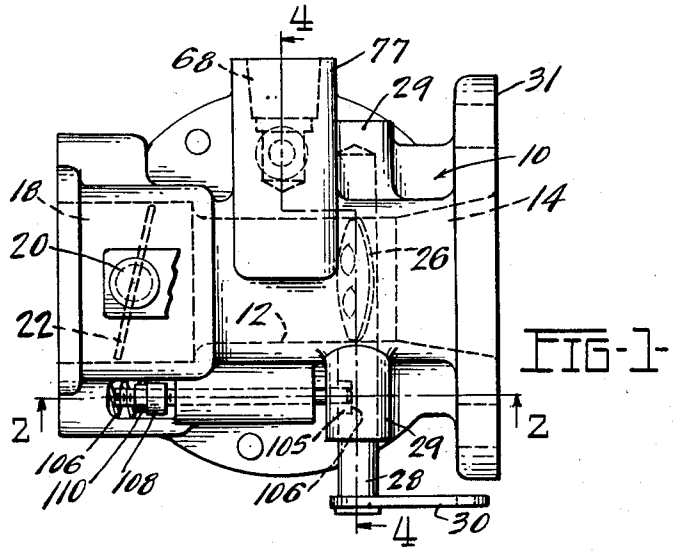


FIG-1-

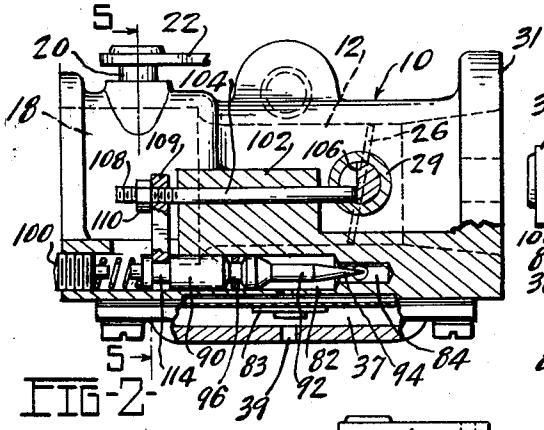


FIG-2-

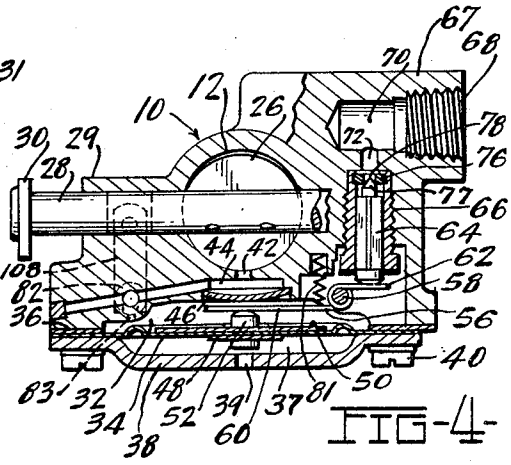


FIG-4-

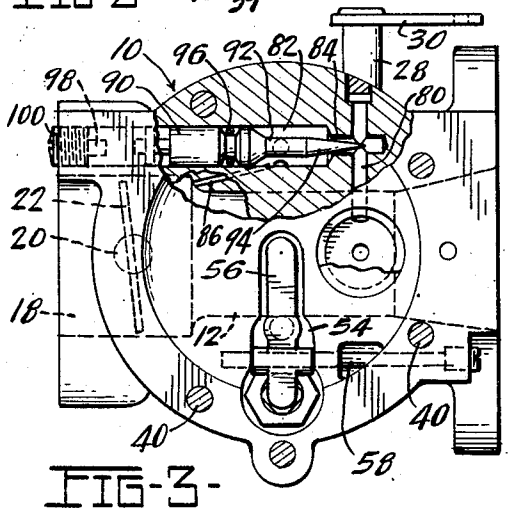


FIG-3-

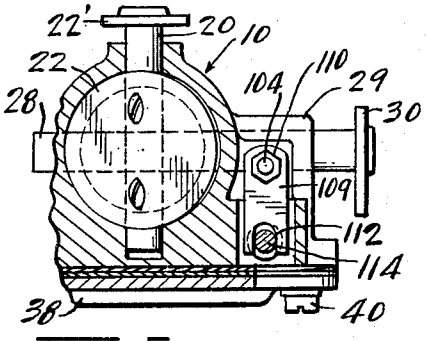


FIG-5-

INVENTOR:
BERNARD C. PHILLIPS
BY
Harry O. Ernsberger
ATTORNEY

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CHARGE FORMING APPARATUS

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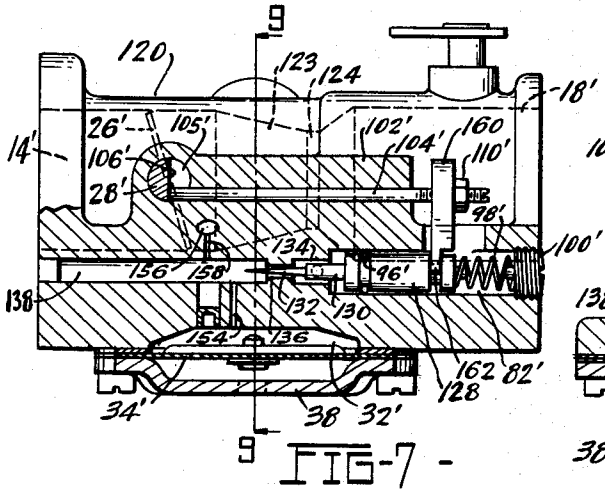


FIG-7

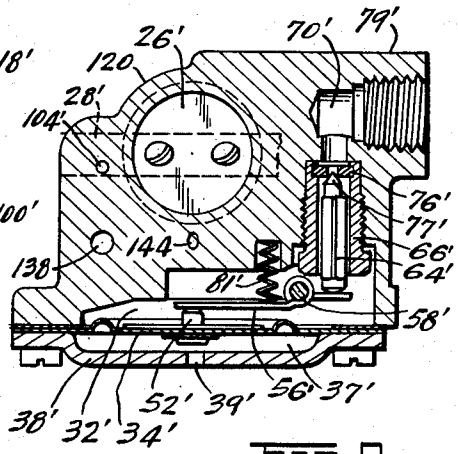


FIG-9

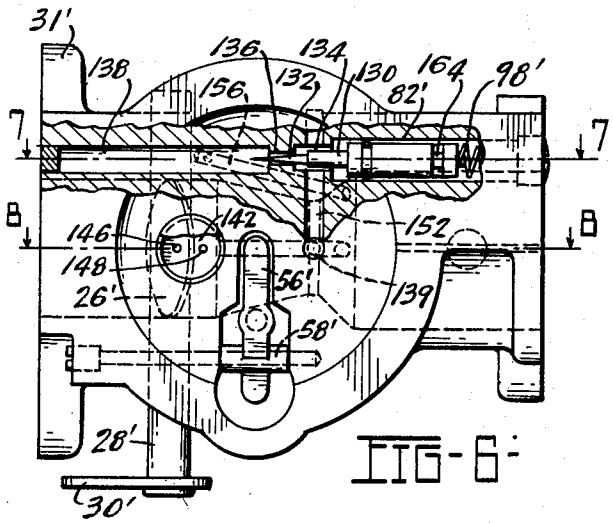


FIG-6

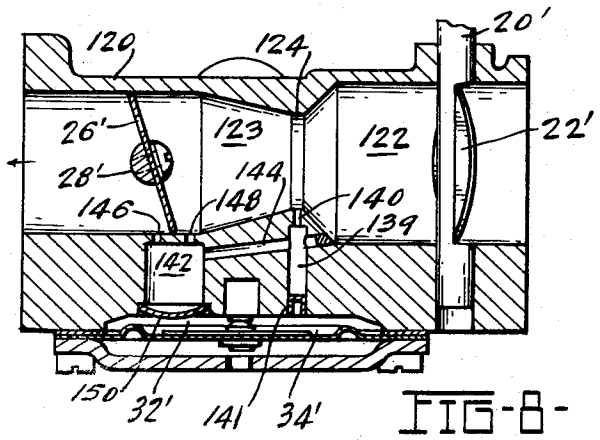


FIG-8

INVENTOR:
BERNARD C. PHILLIPS.
BY
Harry O. Ernsberger
ATTORNEY

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CHARGE FORMING APPARATUS

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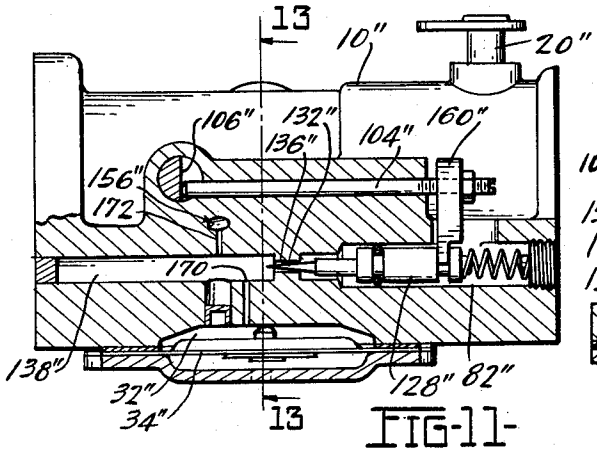


FIG-11-

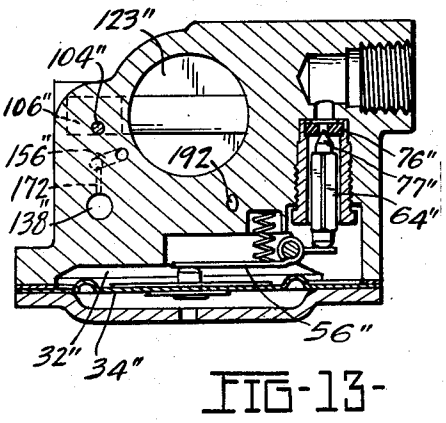


FIG-13-

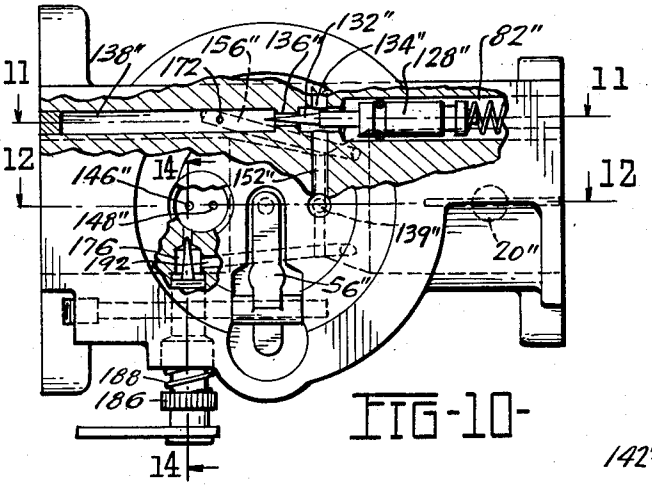


FIG-10-

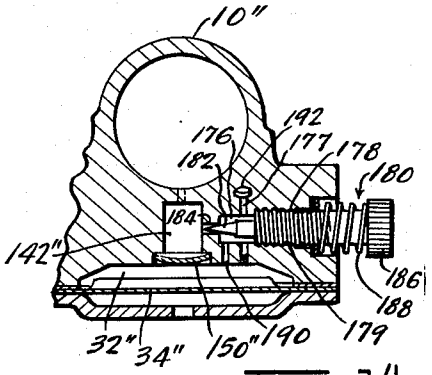


FIG-14-

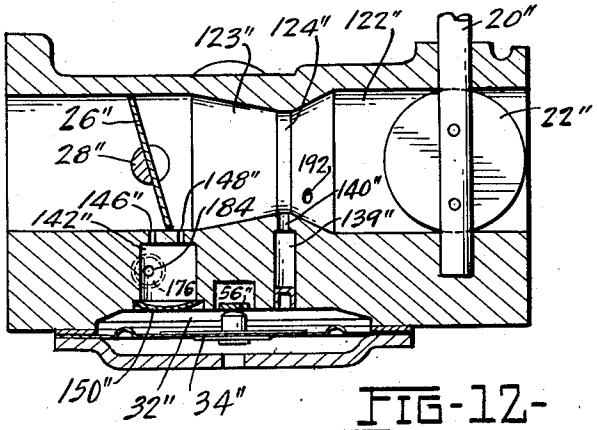


FIG-12-

INVENTOR:
BERNARD C. PHILLIPS.
BY
Harry O. Ernsberger
ATTORNEY

Oct. 10, 1961 B. C. PHILLIPS 3,003,754

CHARGE FORMING APPARATUS

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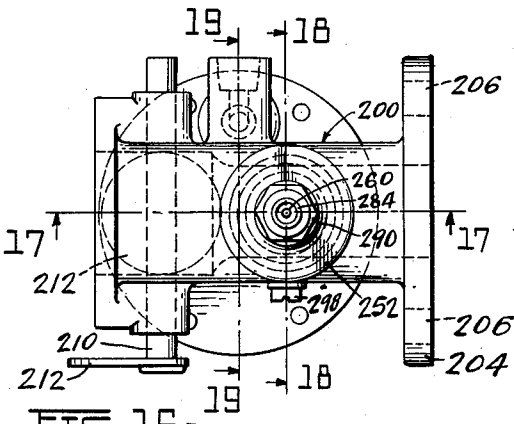


FIG-16-

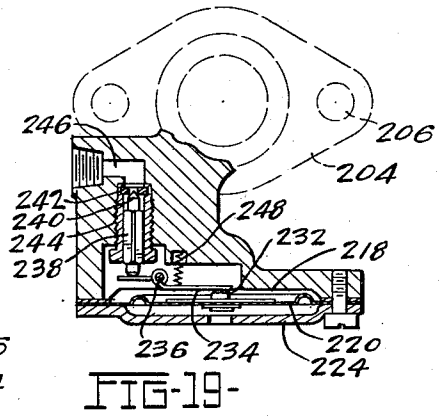


FIG-19-

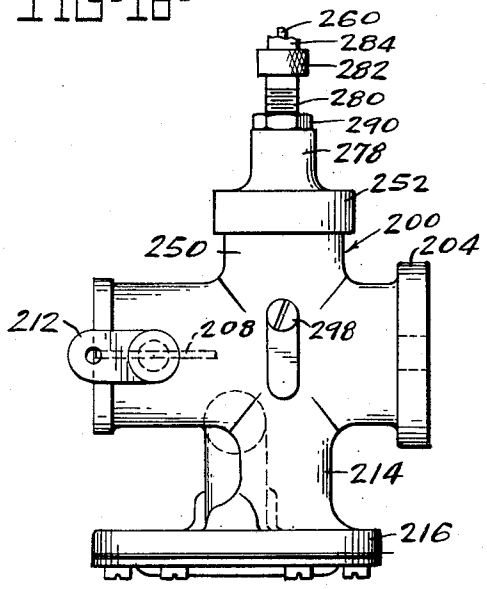


FIG-15-

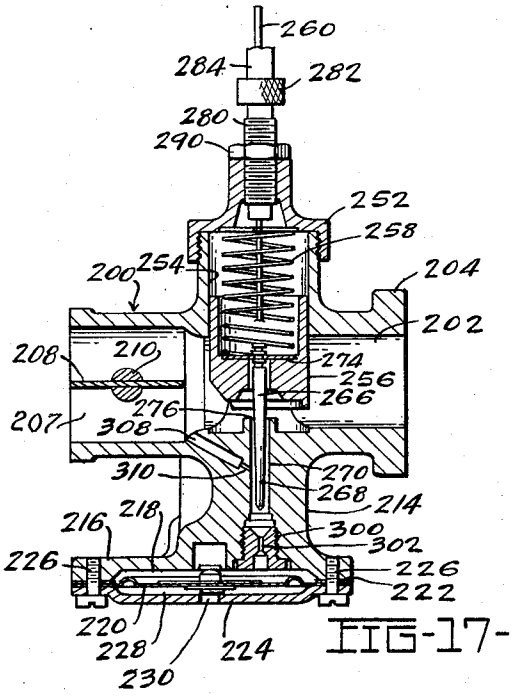


FIG-17-

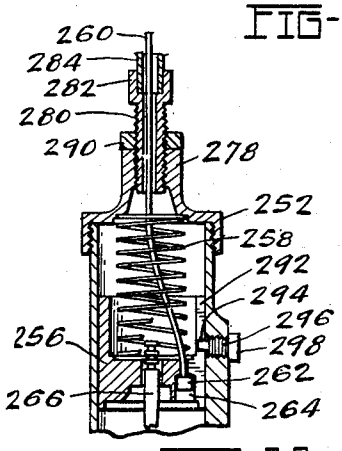


FIG-18-

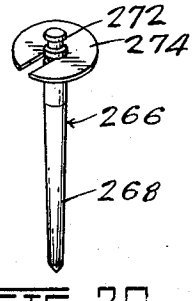


FIG-20-

INVENTOR:
BERNARD C. PHILLIPS.
BY
Harry O. Ernsberger
ATTORNEY

United States Patent Office 3,003,754 Patented Oct. 10, 1961

3,003,754

CHARGE FORMING APPARATUS

Bernard C. Phillips, Toledo, Ohio, assignor to The Tillotson Manufacturing Company, Toledo, Ohio, a corporation of Ohio

Filed Dec. 16, 1958, Ser. No. 780,845
2 Claims. (Cl. 261—37)

This invention relates to charge forming devices or apparatus for use with internal combustion engines and more especially to apparatus for forming a fuel and air mixture wherein the fuel constituent is delivered into the air in a mixing passage solely by aspiration or differential pressure established through engine operation.

Internal combustion engines of both the so-called two cycle and four cycle types are being utilized extensively for powering chain saws, lawn mowers, small boats, and for various other purposes. In certain uses, for example, in powering chain saws the engine and the charge forming device are sometimes tilted to extreme angular and oftimes inverted positions. The conventional type of charge forming device that has been in use for many years embodies a float actuated fuel control means and such charge forming devices are not satisfactory for use with engines which are to be operated in extreme angular positions and cannot be utilized at all for powering chain saws where the saws must be capable of use in inverted positions.

Diaphragm carburetors have been developed which are adaptable for operation in extreme angular or inverted positions, and diaphragm controlled carburetors or charge forming devices embody some form of means to prevent or minimize flooding or excess delivery of fuel into the mixing passage when the charge forming device or carburetor is in an extreme angular or inverted position. One form of means for preventing flooding of fuel into the mixing passage is disclosed in my Patent 2,733,902, granted February 7, 1956, which arrangement embodies a ball check means in the region of the main fuel discharge into the mixing passage which, upon inversion of the charge forming device, interrupts or blocks the flow of fuel into the mixing passage through a main fuel discharge. Another method of avoiding flooding of fuel into the mixing passage upon extreme angular or inverted movements or positions of the carburetor or charge forming device forms the subject matter of my Patent 2,841,372, granted on July 1, 1958. The arrangements in this latter patent utilizes capillary characteristics of the fuel for establishing a fluid seal or block to avoid flooding conditions when the carburetor or charge forming device is utilized in an extreme angular or inverted position.

The present invention embraces a simple but effective means for adjustably metering or varying the fuel delivered into the mixing passage as the speed of the engine with which the device is used is increased or decreased and for restricting fuel flow to the mixing passage under idling or low speed conditions of the engine with which the apparatus is used whereby excess delivery of fuel or flooding of the mixing passage is eliminated.

An object of the invention resides in a charge forming apparatus of the diaphragm type wherein fuel is delivered into the mixing passage solely by aspiration or differential pressure established by the engine with which the apparatus is used wherein the amount of fuel admitted to the mixing passage is metered or regulated in accordance with the amount of air moving through the mixing passage and whereby during idling or low speed operations of the engine, the amount of fuel delivered into the mixing passage is proportionately reduced.

Another object of the invention resides in the provision of a diaphragm type carburetor embodying a controlled fuel metering means, the movement of which is correlated with the movement of the throttle valve to proportionately increase the amount of fuel delivered into the mixing passage dependent upon the extent of opening of the valve and wherein the fuel metering means is adjustable with respect to the actuating means associated with the throttle valve for initially adjusting the relative position of the metering means to secure most efficient operation of the carburetor throughout the operating range.

Still a further object of the invention is the provision of a diaphragm type carburetor embodying a throttle controlled fuel metering means which may be successfully operated in all angular positions and in inverted position without the delivery of excess fuel into the mixing passage and wherein the proportion of fuel and air in the mixing requirements of an engine with which the carburetor may be used.

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

FIGURE 1 is a top plan view illustrating one form of charge forming apparatus or carburetor of the invention;

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

FIGURE 3 is a bottom plan view of the carburetor shown in FIGURES 1 and 2 with the diaphragm and diaphragm cover removed and certain portions being shown in section for purposes of illustration;

FIGURE 4 is a transverse sectional view taken substantially on the line 4—4 of FIGURE 1;

FIGURE 5 is a fragmentary sectional view taken substantially on the line 5—5 of FIGURE 2;

FIGURE 6 is a bottom plan view of a carburetor with certain parts removed and others in section illustrating a modified form of the invention;

FIGURE 7 is a longitudinal sectional view through the carburetor, the section being taken substantially on the line 7—7 of FIGURE 6;

FIGURE 8 is a longitudinal sectional view taken substantially on the line 8—8 of FIGURE 6;

FIGURE 9 is a transverse sectional view taken substantially on the line 9—9 of FIGURE 7;

FIGURE 10 is a bottom plan view of a carburetor embodying another form of the invention;

FIGURE 11 is a longitudinal sectional view taken substantially on the line 11—11 of FIGURE 10;

FIGURE 12 is a longitudinal sectional view taken substantially on the line 12—12 of FIGURE 10;

FIGURE 13 is a transverse sectional view taken substantially on the line 13—13 of FIGURE 11;

FIGURE 14 is a fragmentary detail sectional view taken substantially on the line 14—14 of FIGURE 10;

FIGURE 15 is a side elevational view of a diaphragm type carburetor embodying another form of the invention;

FIGURE 16 is a top plan view of the construction shown in FIGURE 15;

FIGURE 17 is a vertical sectional view through the charge forming apparatus or carburetor, the section being taken substantially on the line 17—17 of FIGURE 16;

FIGURE 18 is a fragmentary sectional view taken substantially on the line 18—18 of FIGURE 16;

FIGURE 19 is a fragmentary transverse sectional view taken substantially on the line 19—19 of FIGURE 16, and

FIGURE 20 is an isometric view of a fuel metering means shown in FIGURE 17.

The charge forming apparatus or carburetor of the present invention is particularly adaptable for use with

either two or four cycle internal combustion engines, such as those employed for powering lawn mowers, outboard marine engines and engines for various industrial purposes, and has particular utility for use with two cycle engines employed for driving chain saws where the charge forming apparatus is subjected to operation in angular and inverted positions.

Referring to the drawings in detail, the arrangement shown in FIGURES 1 through 5 includes a carburetor body or member 10 formed with a mixing passage 12 having an outlet region 14 for connection with a crankcase of a two cycle engine or the intake manifold of a four cycle engine. The mixing passage 12 is provided with an air inlet passage 18, a rotatable shaft 20 extending across the air inlet passage 18 and journaled in suitable bearings formed in the walls of the carburetor body 10. Mounted upon the shaft 20 is a choke valve 22 of the disk type, a portion of the shaft 20 extending exteriorly of the body 10 being provided with a manipulating arm 22.

Extending across the mixing passage 12 is a rotatable shaft 28 journaled in suitable bearing bosses 29 to which is secured a throttle valve 26 of the disk type. An end of the shaft 28 projecting exteriorly of the body 10 is provided with a manipulating arm 30. The carburetor body 10 is formed with a flange 31 provided with openings to accommodate bolts for securing the carburetor to the crankcase of an internal combustion engine of the two cycle type or with the intake manifold of a four cycle engine.

The carburetor body is formed with a comparatively shallow fuel reservoir or chamber 32 which is disposed as close to the mixing passage 12 as possible in order to provide a minimum lift distance between the reservoir and the mixing passage. Extending across the reservoir 32 and forming a wall thereof is a flexible diaphragm or membrane 34 of generally circular shape, the periphery of which engages a gasket 36. A cover 38 is disposed at the exterior face of the diaphragm having its central region recessed to provide a chamber 37 vented to the atmosphere by opening 39 and accommodates movement of the diaphragm.

The diaphragm 34, gasket 36 and cover 38 are held in place by peripherally spaced bolts 40. Fuel from the chamber 32 is admitted into the mixing passage 12 through an outlet or orifice 42 which is in direct communication with a supplemental chamber 44 connected with the chamber or reservoir 32 in a manner hereinafter explained. The supplemental chamber 44 is closed or is separated from the reservoir 32 by means of a Welch plug 46.

Disposed at either side of the diaphragm 34 are thin metal disks or washers 48 and 50 for reinforcing the central portion of the diaphragm, the diaphragm and disks being held together by means of a headed rivet 52. As shown in FIGURE 3, the upper wall region defining the reservoir 32 is formed with an elongated recess 54 to accommodate an arm 60 of a lever or lever member 56 forming a component of means for controlling fuel flow from a supply into the reservoir or chamber 32. The lever 56 is pivotally supported upon a pin 58, the short arm 62 of the lever 56 contacting the lower end of a fuel inlet valve member 64.

The valve member 64 is preferably of triangular or polygonal cross-section so as to facilitate flow of fuel past the body of valve member 64. The valve member 64 is slidably disposed in a bore in a fitting 66 which is threaded into a threaded bore formed in the carburetor body 10. The boss portion 77 formed on the carburetor body is provided with a threaded bore 68 adapted to receive a fitting (not shown) arranged to be connected with a fuel supply for feeding fuel into the bore 70.

The bore 70 is in communication with a duct 72 with a port formed in a valve seat 76 disposed within the upper end of the threaded fitting 66. The annular valve seat member 76 is preferably formed of resilient rubber-like material, such as neoprene (chloroprene), Buna rubber or other material which is resistant to deterioration by hydrocarbon fuels. The valve body 64 is formed at its upper end with a cone-shaped valve portion 77 adapted to cooperate with the seat member 76 to control fuel flow from a supply into the reservoir or chamber 32.

The port or passage in the valve seat member 76 is of comparatively small diameter so that the effective fuel pressure acting against a small area of the cone-shaped valve portion 77 in order to provide for sensitive operation of the fuel inlet control mechanism. The carburetor body 10 is formed with a recess adapted to accommodate an expansive coil spring 81 for biasing the lever 56 in a counterclockwise direction as viewed in FIGURE 4 for urging the valve 77 into contact with the seat 76.

The head of the rivet 52 associated with the diaphragm 34 is always in contact with the lever arm 60 of the lever 56 when the carburetor is in operation. When fuel is delivered through the orifice or outlet 42 into the mixing passage by aspiration or reduced pressure in the mixing passage 12, the diaphragm 34 is moved upwardly, causing pivotal movement of the lever 56 in a clockwise direction permitting the valve member 64 to move downwardly and admit fuel through the port in the valve seat 76 and thereby maintain fuel in the reservoir or chamber 32.

The arrangement of the invention is inclusive of a throttle actuated or controlled means for regulating the admission of fuel into the mixing passage in proportion to the extent of opening of the throttle valve 26. A channel or duct 80 is in communication with the supplemental reservoir 44 or enlarged region adjacent the orifice 42. The carburetor body is formed with a bore 82 which is substantially parallel with the axis of the mixing passage 12.

The end region of the bore 82 is in communication with a bore 84 of reduced diameter, the latter being in communication with the duct or passage 80 as shown in FIGURE 3. The bore 82 is in communication with the reservoir or chamber 32 by means of a channel or duct 83 shown in FIGURE 2 whereby fuel is admitted into the bore 82. If desired, an air bleed passage 86 may be provided between the air inlet 18 and the bore 82 as shown in FIGURE 3 for admitting air to the fuel prior to its delivery through the orifice 42.

Slidably disposed in the bore 82 is a fuel metering means or member 90 formed with a tenon portion 92 of reduced diameter, the extremity 94 of which is of tapered or needle-like shape forming a valve or metering medium restricting fuel flow from the bore 82 into the ducts 84 and 80 into the supplemental chamber 44.

The taper on the portion 94 is of such angularity that movement of the member 90 in a left-hand direction as viewed in FIGURE 3 effects an increase in the area surrounding the tapered portion in the restricted passage 84 to admit more fuel from bore 82 past the needle valve 94. The member 90 is formed with a circumferential groove in which is disposed a sealing ring 96 of resilient material to prevent leakage of fuel along the body portion of the member 90 and exclude foreign matter.

The member 90 is biased in a right-hand direction as viewed in FIGURES 2 and 3 under the influence of an expansive coil spring 98 disposed between the outer end of the member 90 and an abutment member or threaded plug 100 which is threaded into the end region of the bore 82. The amount of spring pressure or bias exerted by spring 98 may be regulated by adjusting the relative position of the threaded abutment 100.

The carburetor body 10 is formed with a boss portion 102 provided with a longitudinal bore in which is slidably disposed a rod or shaft 104. As shown in FIGURE 2, the longitudinal axis of movement of the shaft 104 is below the axis of the throttle supporting shaft 28.

The boss portion 29 adjacent the rod 104 is formed with a bore to receive the end region of the rod. The throttle shaft 28 is formed with a slot or recess 105 adjacent the

end of the rod 104, the base surface 106 of the recess 105 forming a cam surface engaged by the adjacent end of the rod 104 as shown in FIGURE 2.

The opposite end region of the rod 104 is threaded as at 108 to threadedly receive a member or block 109 which may be locked to the shaft or rod 104 by a locking nut 110. The member 109 extends downwardly as illustrated in FIGURE 5, the distal end thereof being bifurcated or formed with an open ended slot 112, the furcations straddling a portion 114 of reduced diameter formed by a circumferential groove in the member 90.

It will be apparent from FIGURE 2 that upon rotational movement of the throttle supporting shaft 28 in a clockwise direction, the cam surface 106 moves the rod or shaft 104 longitudinally and, through the medium of the interconnection between the member 109 and the member 90, the latter will likewise be moved in a left-hand direction against the expansive pressure of the spring 98.

As the tapered needle portion 94 moves in a left-hand direction as viewed in FIGURE 2, a passage of progressively increaseing area is provided between the needle portion 94 and the wall of the bore 84 to facilitate admission of an increased amount of fuel through the duct 80 into the supplemental reservoir 44 for discharge through the orifice 42 into the mixing passage where it is mixed with the air aspirated through the mixing passage under the influence of the movement of the engine piston or pistons.

Thus the greater the opening position of the throttle 26, the more fuel is admitted for discharge into the mixing passage. Upon movement of the throttle toward closed or idling position, the needle portion 94 is moved in a right-hand direction to proportionately reduce the amount of fuel flowing past the needle into the mixing passage, the amount being sufficient to provide an idling mixture for the engine. The throttle 26 in engine idling position is not entirely closed so as to admit a small amount of air for mixing with the reduced amount of fuel required for idling operation of the engine.

The delivery of fuel into the mixing passage 12 only takes place under aspiration set up by operation of the engine whereby the carburetor will operate or function in any angular or even inverted position. If the engine is inverted in idle position, the metering pin or needle 94 is in a position to permit the flow of an amount of fuel necessary to maintain idling operation of the engine.

If the throttle is opened while the carburetor is in inverted position, the metering pin or needle 94 is moved in a left-hand direction as viewed in FIGURES 2 and 3 to permit the passage of an increased amount of fuel proportionate to the amount of air moving through the mixing passage to cause operation of the engine at the desired speed without flooding of the fuel in the mixing passage. The initial or idling position of the metering means 90 with respect to the rod 104 may be obtained by releasing the locking nut 110 and rotating the shaft 104 to effect adjustment of the metering needle 94.

It is to be understood that the abutment or cam surface 106 formed on the throttle shaft 28 may be of curved configuration to change or modify the ratio of fuel to air, or the degree of taper of the metering needle valve 94 may be changed to vary the fuel to air ratio. The spring 98 serves several functions in the apparatus, it exerts a biasing pressure to maintain the shaft 104 in contact with the cam surface 106 and assures positive control of the metering pin by eliminating lost motion that may otherwise exist between the member 109 and the metering means 90. The spring 98 also prevents vibration of the metering pin and fluttering of the throttle valve whereby the throttle and metering means remain stable under severe service conditions and vibration.

In the arrangement illustrated in FIGURES 1 through 5 the mixture control is obtained by a single adjustment and back bleeding through the nozzle under idling conditions is avoided. It is to be understood that the air bleed passage 86 between the air inlet of the mixing passage and the bore or chamber 82 may be omitted depending upon the operating characteristics of the engine with which the carburetor is used.

FIGURES 6 through 9 illustrate a carburetor embodying another form of the invention. The arrangement includes a carburetor body 120 which is similar to the body 10 shown in FIGURES 1 through 5 with certain modifications. The body 120 is formed with a mixing passage 122 embodying a Venturi configuration 123 having a choke band or restricted region 124. The mixing passage 122 is provided with an air inlet 18' provided with a choke valve 22' mounted upon a rotatable shaft 20'.

The mixing passage is provided with an air outlet 14' in which is disposed a throttle valve 26' mounted upon a rotatable shaft 28' provided with a manipulating arm 30'. The carburetor body 120 is formed with a flange portion 31' adapted to be secured to the crankcase of an engine of the two cycle type or to the intake manifold of an engine of the four cycle type.

The carburetor body is formed with a fuel reservoir or chamber 32' one wall of which is formed by a flexible diaphragm or membrane 34', a cover 38' being provided for the diaphragm and having a vent opening 39' to establish atmospheric pressure in the space 37'.

The fuel inlet control means illustrated in FIGURE 9 is substantially the same as that shown in the form of the invention illustrated in FIGURES 1 through 5. The head of the rivet 52' associated with the diaphragm 34' engages one arm of a lever 56' fulcrumed upon a pin 58', the other arm of the lever engaging a valve member 64' slidably mounted in a hollow fitting 66' threaded into a bore in the body 120. A cone shaped valve portion 77' cooperates with a port in a valve seat 76' for controlling flow of fuel from a supply through a passage 70' and a fitting (not shown) threaded into a bore in the boss portion 79'.

A coil spring 81' engages the lever arm in contact with the rivet head 52' biasing the lever in a counterclockwise direction as viewed in FIGURE 9 to bias the valve 77' toward the seat 76'. This form of the invention invention includes a throttle controlled fuel metering means of a character similar to that shown in FIGURES 1 through 5. A bore 82' formed on the body 120 slidably receives a metering means which is inclusive to a member 128 similar to the member 90 shown in FIGURE 2.

One end of member 128 is formed with a tenon portion 130 from which extends a tapered metering valve or needle portion 132 the tenon portion 130 extending into a bore 134 in communication with the bore 82'. The metering needle 132 extends into a restricted passage 136 which is in communication with an elongated chamber 138. The metering means 128 is normally biased in a left-hand direction as viewed in FIGURE 7 under the influence of an expansive coil spring 98' which abuts an adjustable threaded member 100'.

The abutment 100 may be rotated to adjust the pressure of the spring 98' upon the member 128. A sealing ring 96' is disposed in a circumferential groove in the body portion of member 128 to prevent leakage of fuel along the member and to prevent ingress of foreign particles. Disposed in the region beneath the choke band 124 of the Venturi mixing passage 122 is an auxiliary chamber or well 139 which is in communication with a main fuel discharge outlet or orifice 140 opening into the choke band 124 of the Venturi 123.

Formed in the body 120 in a region adjacent the discharge region of the Venturi is an auxiliary chamber 142 which is in communication with the chamber 139 by means of a channel or passage 144. An idling orifice 146 and a low speed orifice 148 in a wall of the mixing passage adjacent the discharge region of the Venturi 123 are adapted to deliver fuel from chamber 142 into the mixing passage for engine idling and low speed purposes.

It should be noted that the idling orifice 146 is at

the engine side of the throttle valve 26' so that when the latter is in nearly closed or idling position, fuel is discharged through the idling orifice 146 under the influence of engine aspiration.

The orifices 146 and 148 are herein referred to as secondary orifices. When the throttle valve 26' is in partially open position, fuel may be discharged from both orifices 146 and 148 depending upon extent of opening of the throttle valve. The chamber 142 is isolated from the chamber 32' by means of a Welch plug 150. The lower end of the passage or chamber 139 is closed by means of a plug 141.

The bore 134 is in communication with the chamber or well 139 by means of a duct 152. Fuel is conveyed from the chamber 32' through a passage or channel 154 shown in FIGURE 7 into the elongated chamber or duct 138. An air bleed means for the fuel in the elongated chamber 138 is provided by a passage 156, one end of which is in communication with the air inlet end of the mixing passage, the other end being in communication with the chamber 138 through a restricted passage 158 as shown in FIGURE 7.

Thus fuel is admitted into the chamber 138 through the passage 154 and air is admitted to the fuel in chamber 138 through the connecting air bleed passages 156 and 158 whereby a mixture of fuel and air is metered or controlled by the needle valve 132 supplied to both the main orifice 140 and the secondary orifices 146 and 148. The metering means 128 is controlled by a cam associated with the throttle in the manner hereinbefore described in reference to FIGURES 1 through 5.

A rod or shaft 104' is slidably mounted in the boss portion 102', one end of the rod 104' engaging the cam surface 106' formed by a recess 105' in the throttle shaft as shown in FIGURE 7.

The opposite end of the rod 104 is threaded to receive a block or member 160 similar to the member 109 shown in FIGURE 5 which may be locked in adjusted position on the rod 104 by a locking nut 110'. The block 160 has a bifurcated portion 162 which straddles a reduced portion 164 formed in the member 128.

Thus when the throttle shaft is rotated, the cam 106' effects longitudinal movement of the rod 104', block 160 and the member 128 carrying the metering needle 132 for adjusting the amount of fuel admitted to the supplemental chamber 139 for discharge through the main orifice 140 or for discharge from the secondary orifices 146 and 148. It should be noted in this arrangement, that the single metering means or needle 132 provides for the fuel adjustment for fuel delivered to all of the discharge orifices.

The operation of this form of construction is as follows: In initially starting the engine with which the carburetor is used, the throttle 26' is moved to open or partially open position and the choke valve 22' moved to closed position. Upon starting the engine the choke valve 22' is gradually opened as the engine warms up. In idling position the throttle 26' is nearly closed and air flow through the passage is restricted so that there is substantial subatmospheric pressure at the engine side of the throttle 26' causing fuel to be discharged through the idling orifice 146.

When the carburetor is provided with the air bleed passage 156, air is admitted into the elongated chamber 138 for mixing with the fuel moving past the metering needle 136 thence into the passage 139 and through the passage 144 into the chamber 142 so that an emulsion or mixture of fuel and air is delivered from the idling orifice 146.

During this period little or no fuel is discharged from the low speed orifice 148 and additional air from the mixing passage may be bled into the fuel through the main orifice 140.

As the throttle 26' is opened to a greater extent, the secondary or low speed orifice 142 comes into operation and delivers fuel and air mixture into the mixing passage in addition to that supplied by the idling orifice 146.

During this operation some air may also be bled into the fuel in chamber 139 from the mixing passage through the main orifice 140. As the throttle is opened to a greater extent, the engine speed increases and hence a greater volume of air at high velocities moves through the mixing passage. Under this high aspiration or differential pressure in the mixing passage, fuel and air mixture is discharged from the main orifice 140 and the delivery of fuel and air mixture through the idling and low speed orifices 146 and 148 is substantially reduced.

As fuel is delivered into the mixing passage from any of the orifices, the diaphragm 34' is elevated effecting a tilting of the lever 56' permitting the valve member 64' to move away from the seat 76' to admit additional fuel into the reservoir or chamber 32' to replenish the fuel delivered into the mixing passage.

As the throttle valve 26' is moved progressively toward open position, the cam surface 106' moves the rod 104' in a right-hand direction as viewed in FIGURE 7 withdrawing the metering needle or member 136 in a right-hand direction thereby increasing the passage area adjacent the metering needle 136 so that an increasing amount of fuel is admitted into the chamber 139 for discharge through the orifice 140 or through the secondary orifices 146 and 148 dependent upon the extent of opening position of the throttle 26'.

In this manner the ratio of fuel to air forming a combustible mixture may be regulated and controlled and the fuel metered in a manner enabling the operation of the carburetor in extreme angular and inverted positions without liability of flooding fuel into the mixing passage as the metering means regulates the fuel flow dependent upon engine speed or engine requirements.

The idling position of the metering needle 136 in the passage 132 may be adjusted by loosening the locking nut 110' and rotating the shaft 104' to change the relative position of the metering pin actuating block 160 with respect to the cam surface 106'. In this form of carburetor or charge forming apparatus the relatively movable metering needle 136 controls the fuel or fuel emulsion supplied to both the main orifice 140 and the secondary orifices 146 and 148.

Another form of charge forming apparatus or carburetor of the invention is illustrated in FIGURES 10 through 14. In this form the carburetor body 10" is formed with a mixing passage 122" embodying a Venturi 123" having a choke band 124". The arrangement is provided with a choke valve 22" mounted on a shaft 20", and a throttle valve 26" mounted upon a throttle shaft 28". The construction includes a flexible diaphragm 34" which through the medium of a lever 56" controls an inlet valve member 64" having a valve portion 77" cooperating with a seat 76" for regulating the ingress of fuel into the reservoir or chamber 32".

This form of the invention includes a throttle control metering pin of substantially the same construction as illustrated in the form of the invention of FIGURES 6 through 9. The throttle shaft is formed with a cam or cam surface 106" which cooperates with a rod 104" to move a block 160" which controls the position of a metering means 128" slidable in a bore 82". The metering means 128" is provided with a metering needle or pin 132" cooperating with a restricted passage 136" for metering or controlling fuel delivered into the mixing passage.

Fuel is admitted into an elongated chamber 138" from the reservoir or chamber 32" through a passage or duct 170. An air bleed for the fuel in the elongated chamber 138" is provided by a duct 156" and a restricted passage 172 whereby air is admitted from the entrance of the Venturi in the mixing passage into the chamber 138" and an emulsion of fuel and air delivered past the metering needle 132". The metering means 128" is

slidable in the bore 82" and is of the same construction as illustrated in the form of the invention shown in FIGURES 6 through 9.

The chamber 134" at the right side of the restriction 136", as viewed in FIGURE 10, is connected with a well or supplemental chamber 139" by means of a channel or duct 152". The fuel in the well 139" is delivered into the choke band 124" through the main fuel discharge orifice or outlet 140". In this form of the invention, the throttle controlled metering needle or pin 132" regulates the amount of fuel delivered through the main orifice 140". The fuel supply for the secondary orifices or idling and low speed orifices 146" and 148" is independent of the fuel supplied to the main fuel discharge orifice 140".

The body is formed with the chamber 142" which is isolated from the chamber 32' by means of the Welch plug 150". Formed in the body 10" is a transversely extending bore 176 which forms an extension of an enlarged threaded bore 178, the latter accommodates the threaded portion 179 of a supplemental fuel adjusting means 180. Formed on the end of the threaded portion 179 is a valve or metering needle 182 which extends into a restricted passage or channel 184 which opens into the chamber or well 142".

The fuel metering means 180 is formed with a knurled manipulating or finger grip portion 186 and interposed between the manipulating portion or head 186 and a ledge provided by an enlarged bore formed in the body 10' is an expansive coil spring 188 which provides a friction component to retain the metering needle 182 in adjusted position. Fuel is admitted directly to the bore 176 from the chamber 32' through a duct or passage 190 shown in FIGURE 14. Means is provided for bleeding air into the fuel in the bore 176.

As shown in FIGURE 10 an air bleed passage 192 opens into the entrance of the Venturi as shown in FIGURE 10 and is in communication with the bore 176 through a restriction 177 to admit air from the mixing passage into the bore 176 for mixing with the fuel in the bore 176. Thus an emulsion or a mixture of fuel and air is provided in the bore 176 which is delivered past the metering needle 182 into the well or reservoir 142" for discharge through the secondary orifices 146" and 148".

The metering needle 182 provides a means for adjustably regulating or controlling the fuel and air mixture or air-bled fuel supplied to the well 142 for the secondary orifices which is completely independent from the throttle controlled means for regulating the emulsion or fuel and air mixture delivered to the well 139" for discharge into the mixing passage through the main orifice 140". Through this arrangement the fuel and air supplied to the mixing passage through the secondary orifices may be accurately controlled and the fuel and air mixture delivered through the main orifice accurately controlled by the throttle actuated metering means 128".

The operation of the arrangement shown in FIGURES 10 through 14 is generally similar to the operation of the arrangement shown in FIGURES 6 through 9 with the exception that the fuel delivered to the secondary orifices 146" and 148" is regulated and controlled independently of the fuel delivered through the main orifice 140".

Another form of the charge forming apparatus or carburetor embodying throttle controlled fuel metering means is illustrated in FIGURES 15 through 20. This arrangement comprises a carburetor body 200 formed with a mixing passage 202, the body being formed with a flange 204. The flange 204 is formed with openings 206 adapted to receive bolts or other means for attaching the carburetor to an engine crankcase or intake manifold. The mixing passage 202 is formed with an air inlet 207 in which is disposed a disk-type choke valve 208 mounted upon a rotatable shaft 210 equipped with a manipulating arm 212.

The body 200 is formed with a depending portion 214 which terminates in a circular disk-like portion 216 fashioned with a circular recess forming an unvented fuel chamber or reservoir 218. Extending across and forming a wall of the chamber 218 is a flexible diaphragm 220, the periphery of which is preferably coincident with the periphery of the disk-like portion 216. Disposed between the peripheral region of the diaphragm and the portion 216 is an annular gasket 222.

Disposed beneath the diaphragm is a cover member 224, the peripheral regions of the cover member, diaphragm 220 and gasket 222 being provided with openings to receive securing bolts 226 which are threaded into suitable openings formed in the peripheral region of the disk-like portion 216. The cover member 224 is depressed at the central region to form a space 228 to facilitate movement of the diaphragm 220, a vent opening 230 being provided to establish atmospheric pressure in the space 228 at all times.

The means for admitting fuel through a valved inlet into the reservoir or chamber 218 and the control means therefor shown in FIGURE 19 are substantially the same as the arrangement illustrated in the other forms of the invention. The head portion of a rivet 232 associated with the diaphragm engages one arm of a lever 234 which is of the same construction as the lever 56 shown in FIGURE 4, the same being fulcrumed upon a pin 236. The other arm of the lever engages the body of a valve member 238 the latter formed with a conically-shaped valve portion 240 which cooperates with a ported valve seat 242 held in a bore in the carburetor body by means of a threaded fitting 244.

Fuel is admitted to a passage 246 formed in the carburetor body in the same manner as described in connection with the other forms of the invention. The lever 234 is biased for movement in a clockwise direction about its fulcrum 236 under the influence of an expansive spring 248. As fuel is discharged into the mixing passage, in a manner hereinafter described, under the influence of reduced pressure in the mixing passage, the diaphragm 220 is elevated as viewed in FIGURES 17 and 19 pivoting the lever 234 in a counterclockwise direction as viewed in FIGURE 19 whereby the valve member 238 moves downwardly to permit fuel to flow through the port in the seat 242 past the valve portion 240 into the reservoir 218.

The charge forming apparatus or carburetor shown in FIGURES 15 through 20 embodies a piston or barrel-type throttle means or valve which is associated with a movable metering device or means for varying or regulating the rate of delivery or flow of fuel to the mixing passage in accordance with opening and closing movements of the throttle. The carburetor body 200 is formed with an upwardly extending generally cylindrical portion 250, the upper exterior region of which is threaded to receive a threaded cap 252. The portion 250 is provided with a circular cylindrical interior surface or bore 254 in which is slidably mounted a cylindrically shaped throttle or throttle member 256 which may be referred to as a piston-type throttle.

The upper portion of the throttle member 256 is provided with an interior bore to accommodate an expansive coil spring 258 which normally biases the throttle 256 toward closed position. In this form of construction, the throttle valve 256 is preferably manually operated by means of a flexible cable or wire 260, the lower end of which is formed with an enlargement or anchor 262 which engages in a recess 264 formed in the throttle valve 256 as shown in FIGURE 18. The throttle member 256 is associated with a fuel metering means or pin 266 which is fashioned with a tapered fuel metering portion 268 arranged to extend into a fuel discharge passage 270 in the manner shown in FIGURE 17.

The upper end region of the movable metering pin 266 is formed with a plurality of peripheral recesses 272 and a circular slotted disk 274 may be selectively received in one of the recesses 272 to establish a connection between

the metering pin and the valve 256. The method of engaging the disk 274 with the metering means 266 is particularly illustrated in FIGURES 17 and 20. The disk 274 seats against the bottom of the bore in the throttle member 256 and the end of the spring 258 engages the disk to hold the same in proper relation for movement with the throttle member 256.

It will be noted that as the tapered portion 268 is progressively reduced in a downward direction as viewed in FIGURES 17 and 20, elevation of the metering pin 266 by movement of the throttle upwardly effects a progressive increase in the area of the annular passage 270 surrounding the tapered portion 268 of the metering means to admit a progressively increasing amount of fuel through the annular fuel discharge outlet 276.

The cap member 252 is formed with a tenon portion 278 which is interiorly threaded to accommodate the threaded portion of a ferrule 280 through which extends the throttle control wire or cable 260. The ferrule 280 is provided with a portion 282 bored to accommodate the extremity of a flexible sheath or guide 284 which encloses the throttle operating cable 260. The opposite end region of the cable 260 may be provided with a manipulating knob (not shown) or other means for moving the cable lengthwise to control the position of the throttle 256.

The ferrule 280 is secured in position by means of a lock nut 290. As shown in FIGURE 18 the throttle valve member 256 is formed with a longitudinal recess or slot 292 which accommodates a tenon 294 formed on a member 296 threaded into a bore contained in the wall of the carburetor body adjacent the throttle. The member 296 is provided with a head portion 298 slotted to accommodate a tool for affixing and removing the member 296. The tenon portion 294 cooperates with the lengthwise slot 292 in the throttle member to prevent rotation of the throttle member.

Formed in the depending portion 214 of the carburetor body is a threaded bore which accommodates a fitting 300 provided with a restricted passage 302 opening into a passage or duct 270. When the throttle is in nearly closed or idling position, the metering pin 266 extends into the passage 270 so that the larger cross-sectional area of the tapered portion 268 decreases the effective area of the passage to thus reduce the fuel flow to that required for engine idling purposes.

The engine idling position of the metering pin 268 may be adjusted or varied with respect to the throttle valve 256 by changing the relative position of the ferrule 280 with respect to the cap member 252. When it is desired to change the idle adjustment, the lock nut 290 is released and the threaded ferrule 280 rotated to move the same lengthwise of the cap 252 which, through the medium of the sheath 284 engaging a fitting (not shown) at the opposite end of the sheath effects an adjustment of the cable 260 lengthwise so as to thereby change the initial or idling position of the throttle member 256 in the mixing passage.

In certain installations it may be desirable to provide an air bleed for the fuel in the passage or duct 270. As shown in FIGURE 17 an air bleed passage 308 may be provided having a restricted portion 310 for admitting air from the inlet end 207 of the mixing passage into the passage 270 for mixing with the fuel prior to its discharge through the outlet or orifice 276 of the passage 270. It is to be understood that the arrangement may be utilized in certain installations without the use of the air bleed 308.

The annular recesses 272 fashioned in the upper end of the metering member 266 are provided so that the initial position of the metering pin with respect to the passage 270 may be adjusted to change the ratio of fuel to air to secure efficient operation in various temperature environments or seasonal changes.

In the operation of this form of construction it will be apparent that an opening movement of the throttle 256, that is, an upward movement as viewed in FIGURE 17 provides for a progressively enlarging passage of air into the engine and, through the medium of the tapered metering means 268, a progressively increased amount of fuel is delivered into the restricted passage formed between the end region of the throttle member 256 and the opposite wall portion of the mixing passage.

Thus as the engine speed increases or decreases, dependent upon the position of the throttle 256, a proportionate increase or decrease in the amount of fuel delivered into the increasing or decreasing amount of air moving through the mixing passage is obtained. It will be apparent in this arrangement that all fuel requirements for idling, low speed and high speed operation are provided from the single passage 270 and outlet 276 as permitted by the relative position of the tapered portion 268 in the passage 270 in accordance with the amount of air moving through the mixing passage.

The charge forming apparatus illustrated in FIGURES 15 through 20 has particular utility for use with engines for powering motorcycles, bicycles and other kindred uses where the carburetor may be subjected to vibration due to road irregularities. Vibration does not appreciably impair or affect the functioning of the diaphragm as fuel is admitted to the mixing passage solely through engine aspiration.

While the forms of the invention illustrated in the drawings embody an element associated directly with throttle valve for actuating the fuel metering means, it is to be understood that other means responsive to change in the position of the throttle valve may be employed to actuate the fuel metering means for varying the fuel flow through the fuel channel.

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

I claim:

1. In combination, charge forming apparatus including a casing formed with a mixing passage, a throttle valve movably disposed in the mixing passage, a fuel chamber formed in the casing, a flexible diaphragm forming a wall of the fuel chamber, the diaphragm being movable inwardly upon depletion of the fuel within the chamber, a fuel inlet for the fuel chamber, valve means for the fuel inlet, means actuated by movement of the diaphragm for controlling said fuel inlet valve means, a fuel discharge orifice opening into the mixing passage, a fuel duct between the orifice and the fuel chamber, the throttle valve mounted on a rotative shaft extending transverse of the mixing passage, said shaft having a portion with a cam surface thereon positioned outside of the mixing passage and in the casing, a fuel metering assembly comprising a reciprocating fuel metering member movable to vary fuel flow through the fuel duct, a reciprocable rod mounted in the casing in a direction generally normal to the throttle valve shaft and having one end which engages the cam surface, the reciprocable fuel metering member being mounted in the casing in a bore disposed parallel to the reciprocable rod and having a tapered forward portion which is positioned within the duct, a connecting member connected to the reciprocable rod at its other end and engaging the fuel metering member so that movement of the reciprocable rod will change the position of the metering member, a spring mounted in the casing which engages a rear portion of the metering member to hold the rod against the cam surface and assure position control of the metering member, and the connecting member threadedly engaging the reciprocable rod whereby rotation of the reciprocable rod with respect to the connecting member will adjust the position

of the reciprocable rod with respect to the metering member.

2. The charge forming apparatus of claim 1 wherein a threaded plug is mounted in the casing in line with the rear of the fuel metering member and engaging said spring member whereby pressure on the metering member may be varied.

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