

Dec. 6, 1955

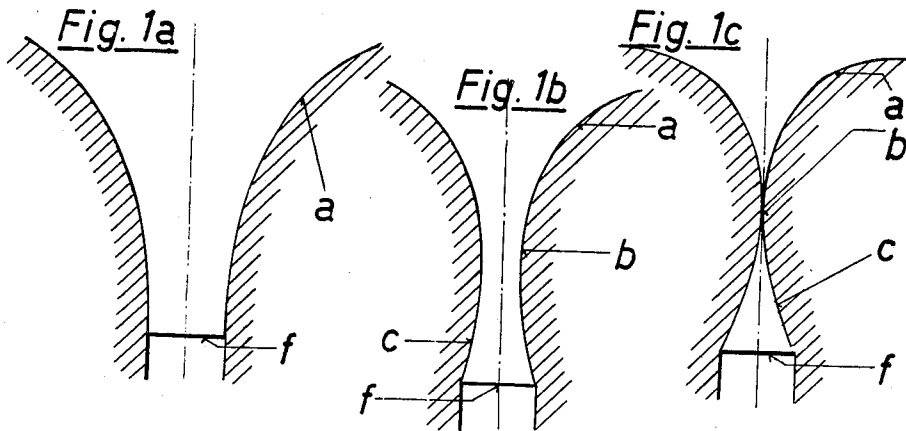
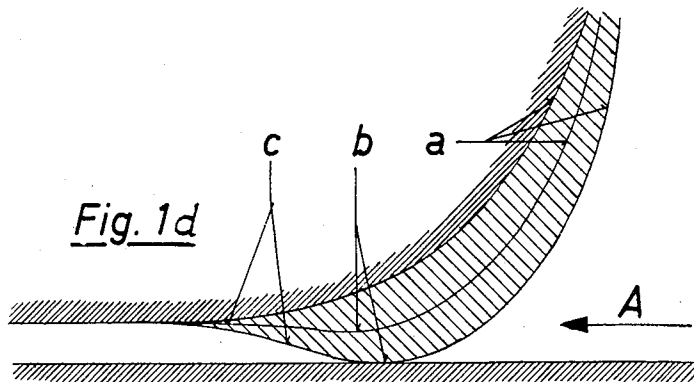
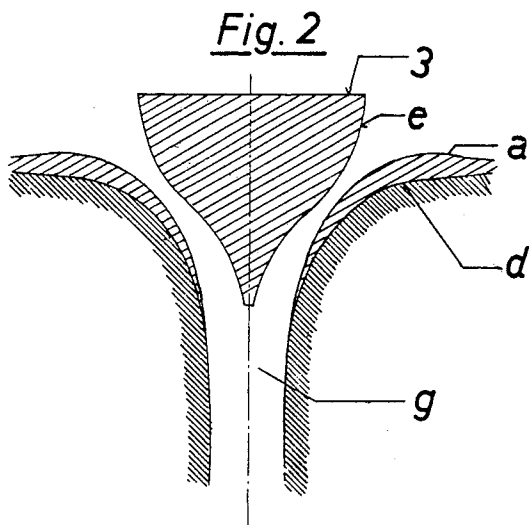
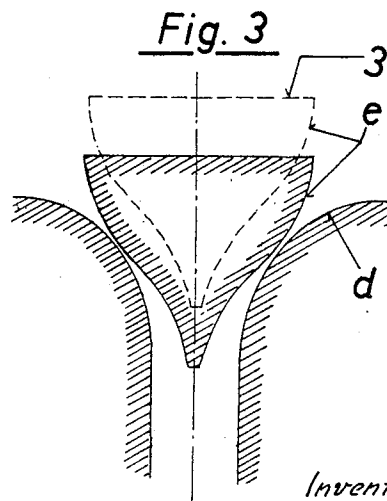
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2,726,073

CARBURETOR FOR INTERNAL COMBUSTION ENGINES

Filed Jan. 14, 1953

6 Sheets-Sheet 1



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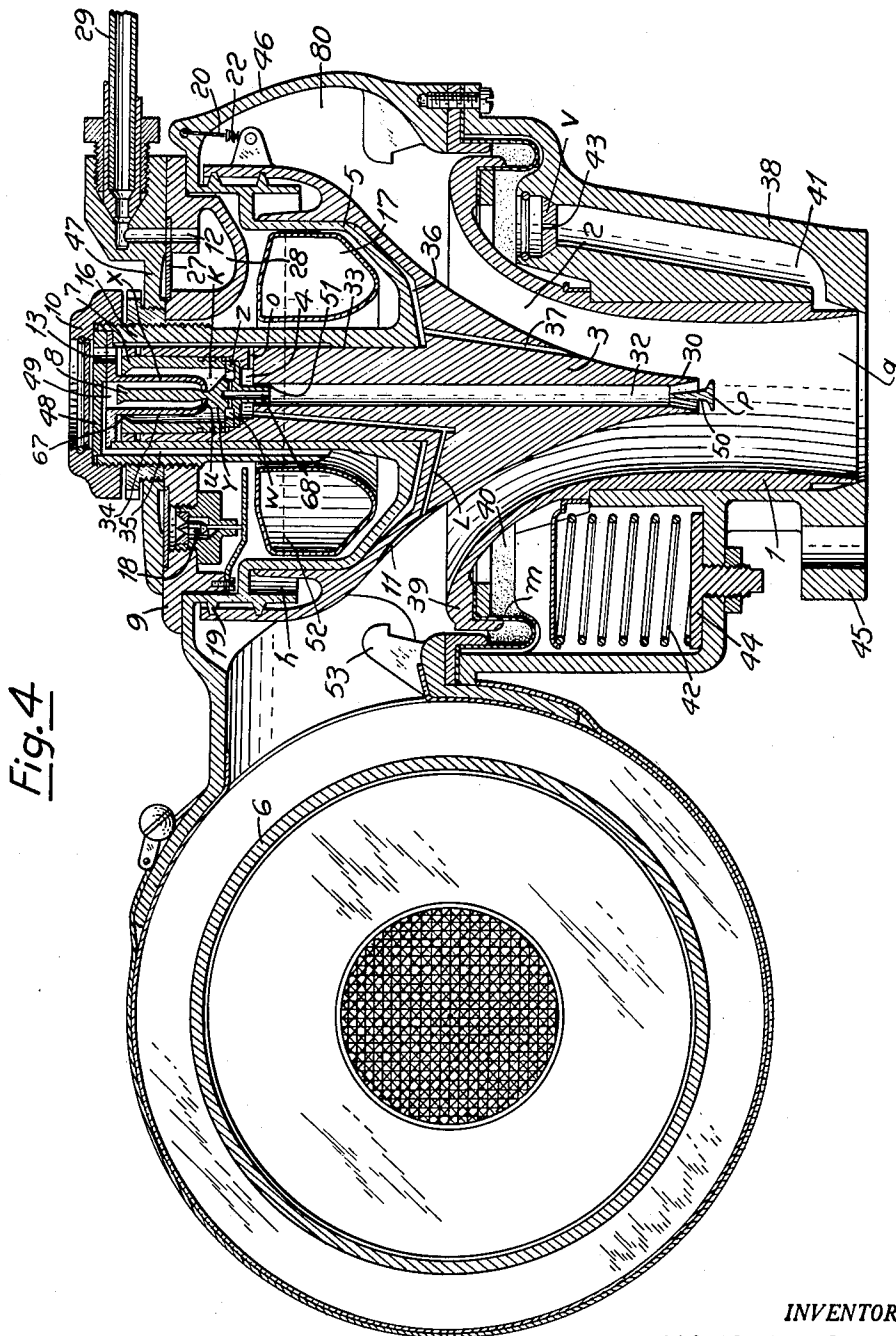
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CARBURETOR FOR INTERNAL COMBUSTION ENGINES

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6 Sheets-Sheet 2



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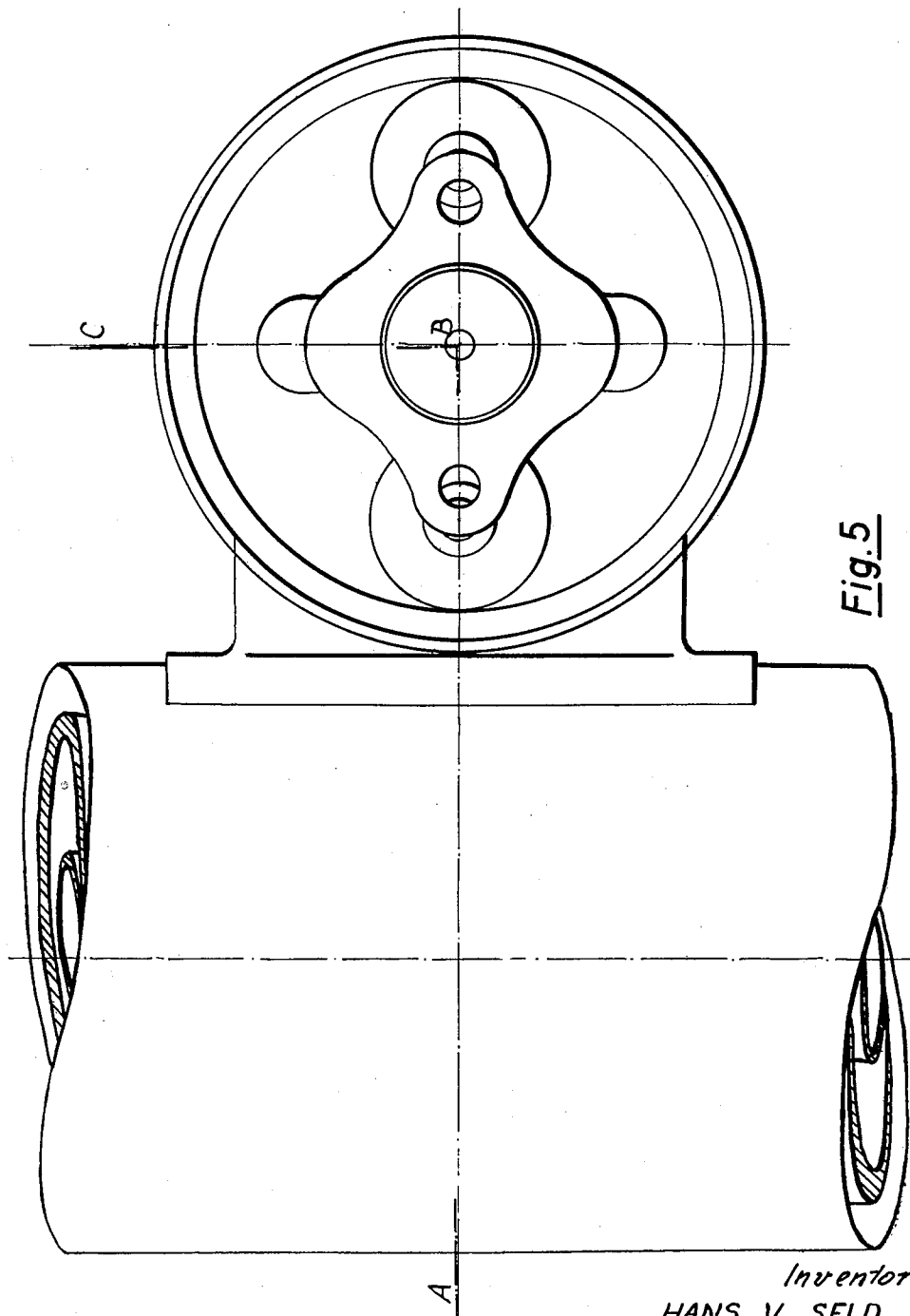
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CARBURETOR FOR INTERNAL COMBUSTION ENGINES

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6 Sheets-Sheet 3



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CARBURETOR FOR INTERNAL COMBUSTION ENGINES

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6 Sheets-Sheet 4

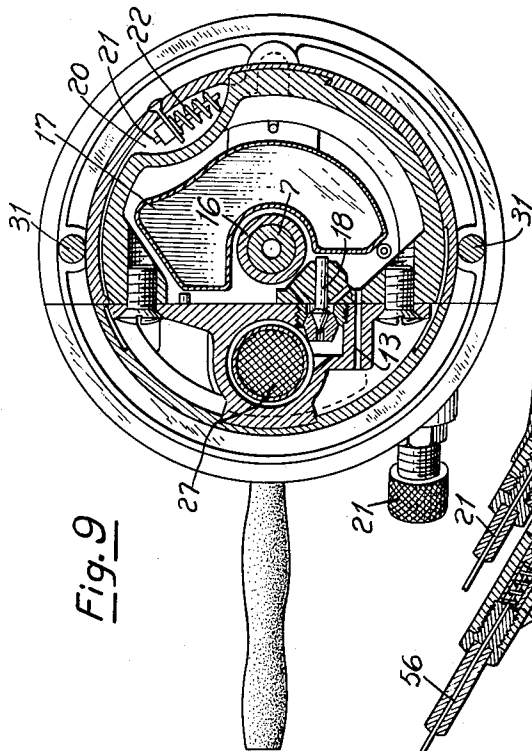


Fig. 9

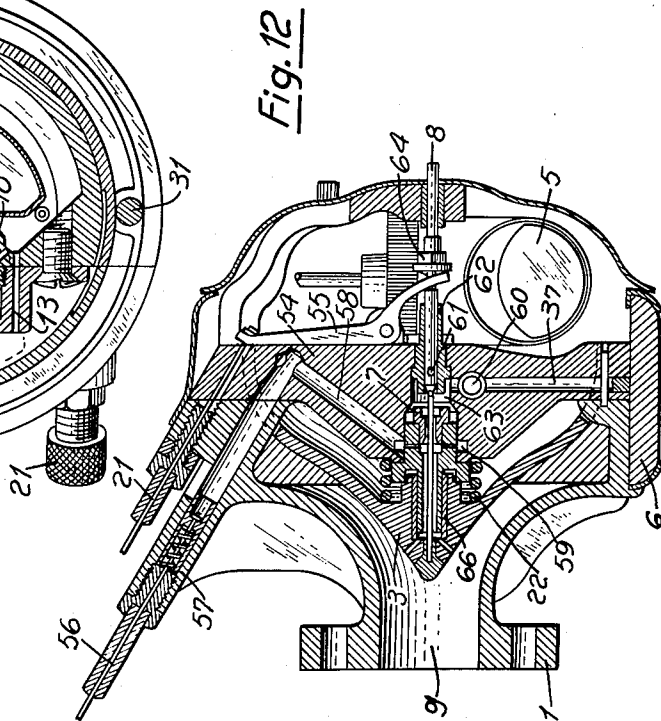


Fig. 12

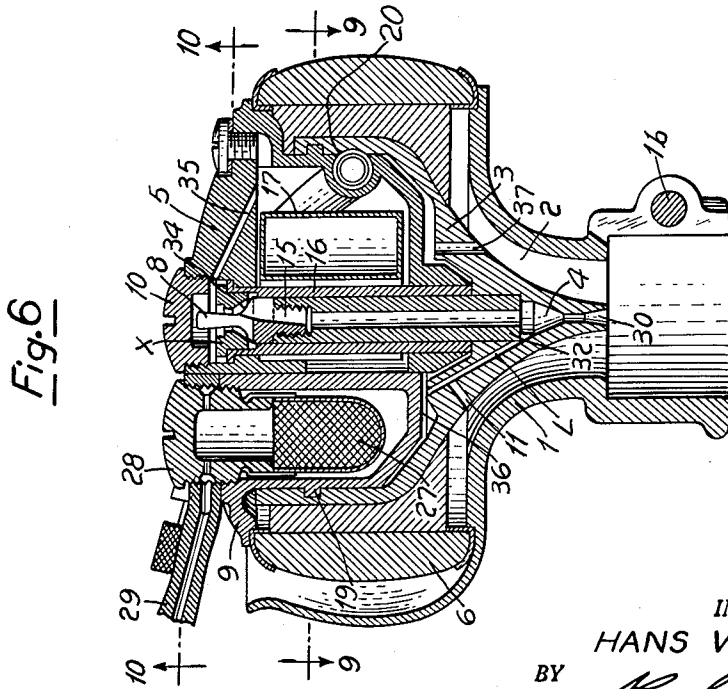


Fig. 6

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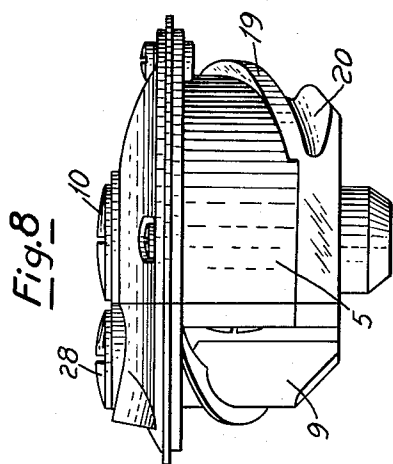
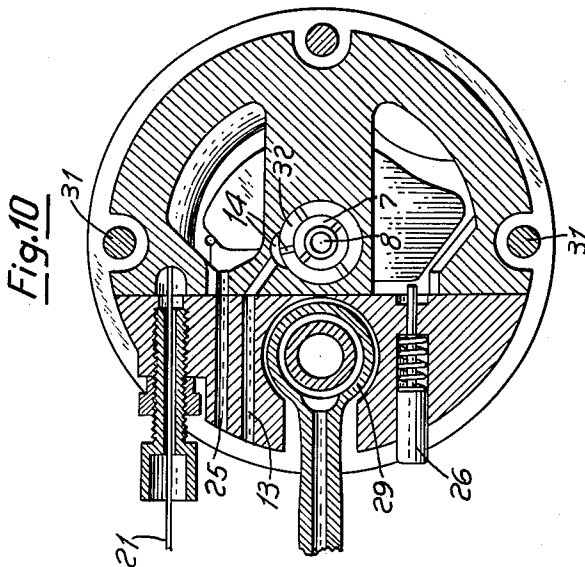
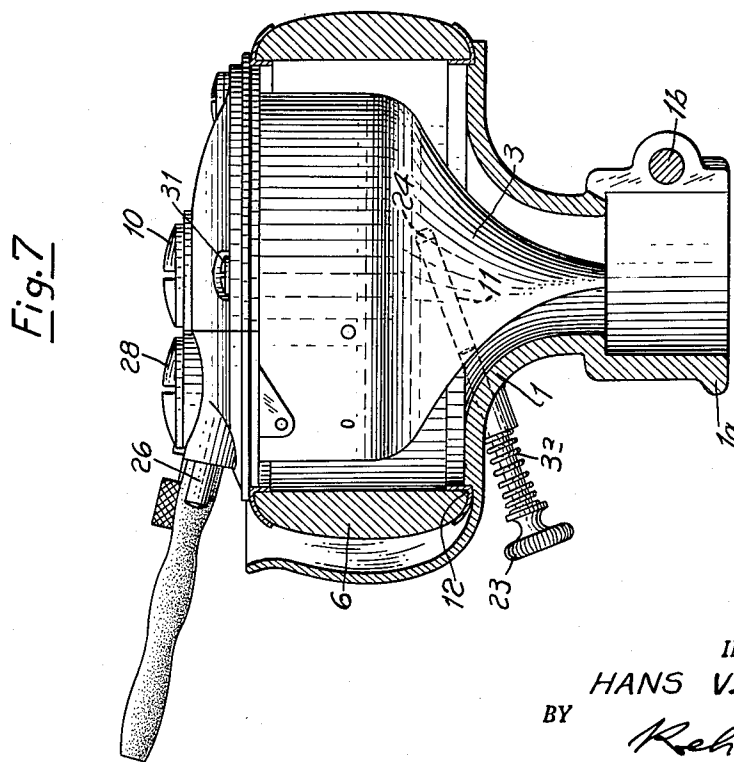
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6 Sheets-Sheet 5



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6 Sheets-Sheet 6

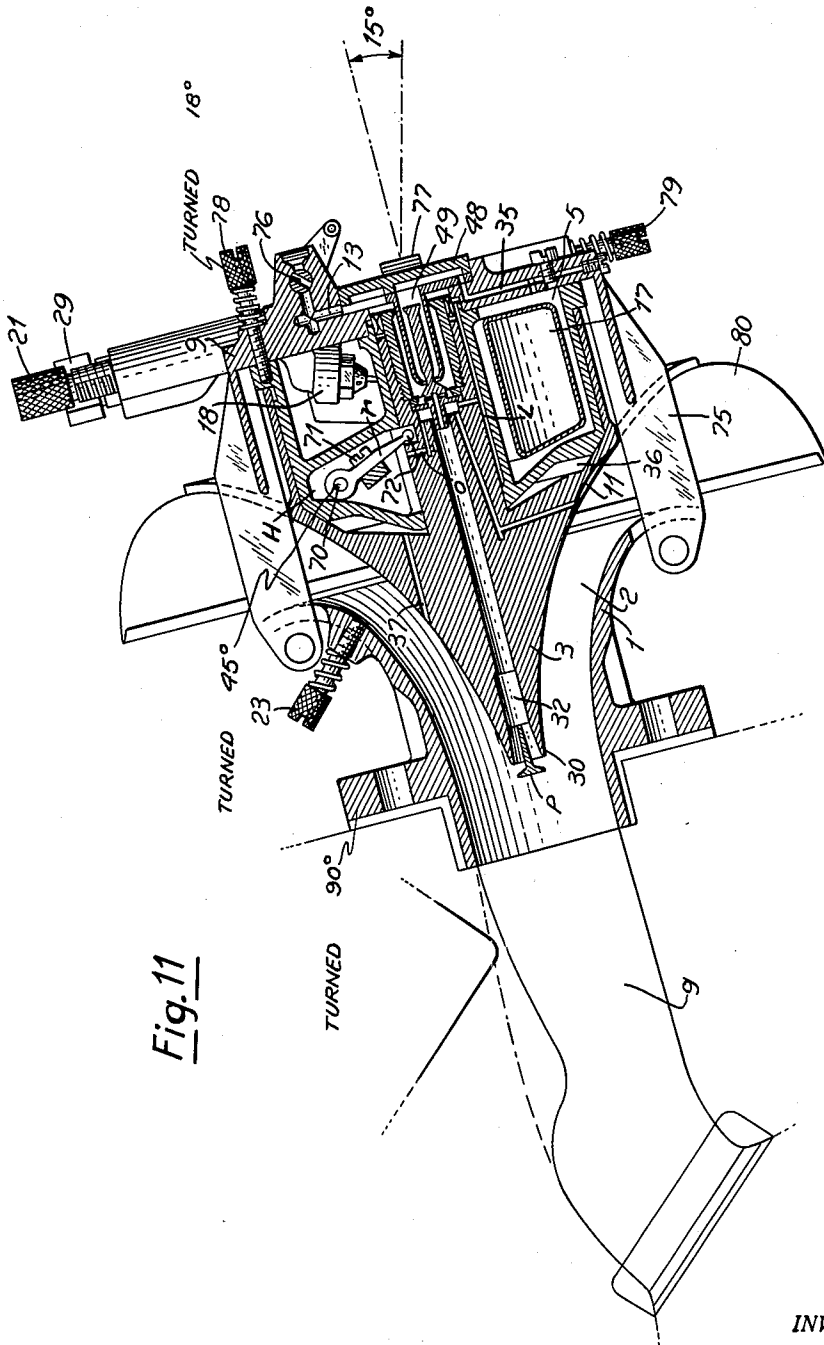


Fig. 11

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CARBURETOR FOR INTERNAL COMBUSTION ENGINES

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35 Claims. (Cl. 261-44)

The present invention relates to carburetors for internal combustion engines, and is particularly directed to a carburetor for an internal combustion engine having a radially variable throat section and wherein the cross-section of the throat section is varied without deviating from the shapes which are shown by aerodynamic theory to be the most favorable for the flow of fluids in tubes and is clear of any obstructions which might interfere with smooth or laminar flow through the throat section.

The interior surfaces or passages of conventional carburetors are usually formed with abrupt changes in cross-section and have interfering elements, such as, for example, the throttle or butterfly valve, the choke valve, the fixed venturi and the discharge nozzle, located in the flow path of fluids through the throat section, so that the flow of fluids through the carburetor is not streamlined or laminar. In these conventional carburetors, the diameter of the venturi section is usually substantially smaller than the diameter of the inlet to the engine manifold thereby limiting the fuel supply to the engine at high speed, and at slow engine speeds the diameter of the venturi section is too large and results in a relatively slow passage of the air through the venturi which causes non-uniform mixing so that the fuel-air mixture delivered to the engine manifold contains overly large fuel particles. Since the fuel discharge nozzle is located ahead of the throttle or butterfly valve in conventional carburetors, the pressure at the fuel discharge nozzle varies only slightly with the various operating conditions and it is therefore difficult to make the actual supply of fuel conform to the real fuel requirements for the various operating conditions.

In the past, attempts have been made to obtain satisfactory fuel-air mixtures over the entire range of operating conditions by providing carburetors having complex air intake arrangements employed in connection with multiple fuel discharge nozzles, but the resulting fuel consumption was still far less favorable than that obtained in engines equipped with fuel injection systems. So long as a fixed venturi is employed, it is impossible to avoid the unsatisfactory compromise inherent in that element, namely inadequate mixing at slow engine speeds and reduced engine output at high speeds.

Accordingly, it is an object of the present invention to provide a carburetor for internal combustion engines which includes a venturi having a cross-sectional area variable between zero and the cross-sectional area of the inlet to the engine manifold and arranged so that the shape of the venturi, at all conditions of operation, conforms to that which aerodynamic theory indicates is most favorable for streamlined flow for the respective conditions of operation.

Another object is to provide a carburetor constructed so that a radial effect is obtained to cause efficient mixing of the fuel and air at a low pressure zone in the center of the flow even during operating conditions resulting in a very slow air flow through the carburetor.

Another object is to provide a carburetor of the de-

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scribed character wherein the cross-sectional area of the venturi is controlled automatically in response to variations in the vacuum in the engine intake manifold, and this automatic control is superimposed upon the control of the venturi cross-sectional area as exercised by the operator.

Another object is to provide a carburetor of the described character which has a single, continuously variable fuel discharge nozzle constructed so that it cannot become clogged, and wherein the atomization of the fuel occurs in three stages to produce a particularly fine fuel-air mixture.

Still another object is to provide a carburetor of the described character which permits a high degree of overloading of the associated engine so that engine may be driven in high gear even at relatively low speeds.

A further object is to provide a carburetor of the described character which, when associated with an internal combustion engine, improves the acceleration, hill climbing and high speed performance of the engine, and which is substantially unaffected by temperature changes so that the associated engine may be operated at its top speed immediately after a cold start.

In accordance with the present invention, the intake portion of the carburetor throat is shaped according to an ideal flow hyperboloid, with the diameter thereof, gradually diminishing to that of the intake manifold of the associated engine and the reduction of diameter corresponding to the theoretically determined magnitude of air friction. Further, for operation at partial throttle, the above described basic form is modified so that ideal flow hyperboloids are provided which reduce to a diameter smaller than that of the engine intake manifold and each of which is followed by theoretical venturi and then a corresponding Laval valve widening to the diameter of the intake manifold. Even at idling speed, the passage through the carburetor presents ideal flow hyperbolas which taper to zero and lead to an adjoining venturi and a Laval valve. Because of the hyperbolic configuration of the throat passage, opening of the passage from the idling condition results in the air immediately following the prescribed path of intake so that the acceleration of the air stream through the carburetor approaches the theoretically maximum value possible, and the continuous transformation of energy between its potential and kinetic forms is avoided. Further, carburetors embodying the above features achieve substantial differences in the vacuum at the fuel discharge nozzle in response to different operating conditions, and these differences in vacuum are comparable to those obtained in a conventional carburetor in which the throttle valve is omitted and operation is controlled only with a choke valve located ahead of the fuel discharge nozzle.

In order that the present invention may be easily understood, illustrative embodiments are shown in the accompanying drawings forming a part hereof and wherein:

Fig. 1a is a schematic view showing the ideal axial sectional configuration for intake flow in a carburetor embodying the present invention in the no throttling condition;

Fig. 1b is a schematic view similar to Fig. 1a, but for partial throttling;

Fig. 1c is a schematic view similar to Fig. 1b, but for full throttling or idling condition;

Fig. 1d is a schematic view of various ideal axial sectional configurations for intake flow in a carburetor embodying the present invention, with the configurations for different operating conditions shown superposed on each other;

Fig. 2 is a schematic axial sectional view of a carburetor embodying the present invention and having a

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passage therethrough shaped in accordance with the principles illustrated in Figs. 1a, 1b, 1c and 1d;

Fig. 3 is a view similar to Fig. 2, and showing the carburetor in the idling and no throttling conditions;

Fig. 4 is an axial sectional view of a down-draft carburetor embodying the present invention and adapted for association with the internal combustion engine of an automobile, with the view being taken along the line A—B—C of Fig. 5;

Fig. 5 is a bottom plan view of the carburetor of Fig. 4;

Fig. 6 is an axial sectional view of another embodiment of the present invention;

Fig. 7 is a view similar to Fig. 6, but with internal parts of the carburetor being shown in elevation;

Fig. 8 is an elevational view of an assembly disposed within the carburetor of Fig. 6;

Fig. 9 is a sectional view taken along the line 9—9 of Fig. 6;

Fig. 10 is a sectional view taken along the line 10—10 of Fig. 6;

Fig. 11 is an axial sectional view of a carburetor for a racing motorcycle constructed in accordance with another embodiment of the present invention; and

Fig. 12 is an axial sectional view of a carburetor for motorcycles constructed in accordance with still another embodiment of the present invention.

Referring to the drawings in detail, and initially to Figs. 1a, 1b and 1c thereof, it will be seen that the ideal axial cross-section through the intake flow in a carburetor is defined by hyperboles *a* tapering or converging to a diameter *f* which is the diameter of the intake manifold of the associated internal combustion engine (Fig. 1a). At slow engine speed or partial throttling (Fig. 1b), the hyperboles *a* are followed by an ideal venturi *b* which widens in the direction toward the intake manifold in the shape of an ideal Laval valve, as at *c*, to the diameter *f* of the intake manifold. Similarly, during idling, the ideal axial flow cross-section (Fig. 1c) includes hyperboles *a* coming together at the venturi *b* and then widening to the intake manifold diameter *f* at a Laval valve section *c*. In this description, the phrase "Laval valve section" is used to denote a passage of conically increasing diameter wherein the angle between any portion of the wall defining the passage and the axis of the latter is no greater than 8 degrees.

In Fig. 1d the air flow is assumed to be in the direction of the arrow A and the vertical distances between the flat horizontal plane and the various curves thereabove represent the annular dimensions of the carburetor flow passage for different operating conditions. Thus, the vertical distances between the horizontal plane and the uppermost curve, representing the outer wall of the flow passage, indicate the ideal radial dimensions for the no throttling condition, and the vertical distances between the horizontal plane and the two other curves including the hyperboles *a*, venturis *b* and enlarging sections *c*, indicate the ideal radial dimensions of the flow passage for partial throttling and for idling, respectively. The shaded area between the uppermost and lowermost curves in Fig. 1d represents the variation in the total opening through the carburetor depending upon the relative positions of the parts of the carburetor defining the flow passage through the latter. The ideal intake configurations represented by Figs. 1a, 1b, 1c and 1d need not necessarily be radially symmetrical.

In Fig. 2, the passage through a carburetor embodying the present invention is shown schematically in axial section with the passage being formed in accordance with the principles illustrated in Figs. 1a, 1b, 1c and 1d. Thus, the ideal flow hyperbola *a* has had the shaded area of Fig. 1d taken therefrom and the widened outer wall is represented at *d*, and the volume between the ideal hyperbola *a* and the enlarged surface *d* is superimposed on the surface of an inverted cone to provide a concave conical surface *e* on the member 3 which is supported for axial movement. Since the area between the curves

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a and *d*, representing the enlargement of the intake passage, has been added to the member 3 to similarly reduce the cross-sectional area of the intake passage, it is apparent that the latter will vary in accordance with the curves of Figs. 1a, 1b and 1c depending upon the axial position of the member 3 relative to the wall *d*. Thus, in Fig. 3, the full line position of member 3 represents the idling condition of the carburetor and the broken line position of member 3 represents the completely throttled condition. From Fig. 3 it can be seen that the space between the generally conical member 3 and the wall *d* of the carburetor throat consists of a fixed portion and a variable portion which is defined by the difference between the broken and full-line positions of the member 3. The fixed and variable portions of the space together yield the ideal flow section of Fig. 1d and the course of this ideal flow section may be changed linearly by axial movement of member 3 and quadratically by radial movement.

The transformation of the section shown in Fig. 1a into an annular section, as in Fig. 2, provides a radial flow effect at the vertex of the member 3 since the air flow tends to follow the concave curvature of wall surface *e* which defines the air path and the air flow velocity increases because of the decrease of surface area at the vertex of member 3. Thus, even when the carburetor is in its unthrottled condition, a zone of reduced pressure is created at the vertex of member 3 to extract a fuel froth mixture from an opening (later described in detail) at the vertex, and this mixture is fully atomized into a fog in the throat *g* (Fig. 2).

In Fig. 4 an actual embodiment of the present invention is illustrated in detail and represents a down-draft carburetor for use in association with an automotive internal combustion engine. The carburetor of Fig. 4 includes a lower body 38 having an upstanding cylindrical passage formed therethrough and a flange 45 at its lower end for mounting upon the intake manifold (not shown) of an associated internal combustion engine. The flow passage 2 through the carburetor is defined by the outer surface of a throttle body 3 having the shape of the surface *e* in Figs. 2 and 3, and the internal surface of a flaring intake pipe 1 having the shape of the surface *d* in Figs. 2 and 3. At its lower portion, the intake pipe 1 is formed with a cylindrical outer surface received in the upstanding cylindrical passage of the lower body 38 so that the intake pipe 1 is movable axially, up and down, relative to the lower carburetor body 38. A rim 39 is formed at the upper edge or periphery of the flaring intake pipe 1, and a flexible seal or diaphragm *m* extends between the rim 39, to which it is clamped, and the adjacent wall of the carburetor body 38. The carburetor body 38 is shaped internally to provide a space 40 opening upwardly against the underside of the flaring top portion of intake pipe 1, and the membrane *m* acts to seal the space 40 from communication with the flow passage 2 defined between the internal and external surfaces of the intake pipe 1 and the throttle body 3, respectively. A spring abutment is secured on the exterior of the intake pipe 1 within the space 40, and compression springs 42 (one being shown in Fig. 4) are interposed between the abutment on intake pipe 1 and adjustable abutments or supports 44 at the bottom of space 40 so that the springs 42 yieldably urge the intake pipe 1 upwardly or in the axial direction causing restriction of the flow passage 2.

In order to effect control movement of the intake pipe 1 in response to variations in the vacuum created in the intake manifold of an associated engine, the lower body 38 of the carburetor is formed with internal ducts or passages 41 which extend from the space 40 and open radially inward into the carburetor throat *g* at locations adjacent the mounting flange 45. A valve V having a flow regulating orifice 43 is interposed in each duct 41 and provides limited communication between the space 40 and the lower part of the throat *g*. Since the pressure

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in the throat *g*, and hence in the space 40, will be more or less lower than the pressure in the passage 2, a force will act downwardly on the intake pipe 1 against the force exerted by the springs 42. Thus, the position of the intake pipe 1 for any operating condition will be determined by the relationship of the spring forces and the pressure unbalance between passage 2 and space 40.

The carburetor of Fig. 4 further includes an upper body 46 which is clamped to the upper edge of the lower body 38, with the outer edge of the membrane *m* being secured between the clamped together edges of the lower and upper bodies. Stops 53 are provided on the interior of upper body 46 to limit the upward movement of the intake pipe 1, and these stops may be adjustable, if desired. The upper body 46 is formed with an air inlet at one side to which a suitable air filter 6 is secured tangentially so that the primary air enters the passage 2 from the filter 6. The upper body 46 is formed with a cup shaped depression 5 at the top having a hollow, open ended cylindrical wall 16 extending upwardly from the center thereof. The depression 5 defines a float chamber around the upstanding cylindrical wall 16.

The outer wall of the depression 5 is cylindrical and the throttle body 3 is formed with a recess corresponding in shape to the recess 5 so that the throttle body 3 fits over the depression 5 and is movable axially and rotationally relative to the latter. In order to effect axial movement of the throttle body 3 for regulating the flow passage 2, a skirt *h* depends from the top of upper body 46 concentric with the recess 5 and is formed with external threads 19 of large pitch, and the throttle body 3, at its upper portion, is formed with a cylindrical outer rim extending around the skirt *h* and having a helical groove in its internal surface engaging the threads 19, so that the throttle body 3 is axially displaced relative to the carburetor body when the throttle body is rotated. Rotation of the throttle body 3 is effected by a Bowden cable 20 connected thereto and extending out of the upper body 46 for manipulation by suitable operator controlled means (not shown). While the embodiment of the invention illustrated in Fig. 4 effects vertical movement of throttle body 3 by a thread arrangement and means for rotating the throttle body, it is apparent that other conventional mechanisms may be employed for effecting such vertical movement.

A cover is provided for the float chamber 5 and includes a lower portion 9 and an upper portion 47 which are superposed with a fuel filter 27 interposed therebetween. A fuel supply pipe 29 connects to an inlet coupling on the upper portion 47 and the fuel passes downwardly from the coupling through a passage 12 and into a dirt and water trap 28 formed in the lower portion 9 of the cover. From the trap 28, the fuel passes upwardly through the filter 27 into a channel defined by a shallow groove in the bottom surface of cover portion 47 and which conducts the fuel to a location over a conventional needle valve assembly 18. A ring-shaped float 17 is provided in the float chamber 5 and is free to rise, fall and tilt with the level of the fuel within the float chamber. The float 17 and valve assembly 18 cooperate to maintain the level of fuel in chamber 5 substantially at the level 52 in the usual manner. That is, the valve assembly 18 is normally open to permit flow of fuel into chamber 5 and, when the level of the fuel rises above the line 52, the float 17 engages the valve assembly 18 to close the latter until the fuel level has receded.

An axial bore 35 is formed in the cylindrical wall 16 and opens at the bottom into the float chamber 5 to receive fuel from the latter and deliver such fuel to a preliminary mixing arrangement which will now be described. A central axial bore 32 extends through the throttle body 3 and opens at its lower end at the vertex or tip 30 of the onion-shaped outer surface of the body 3. An atomizing or dispersing plate *P* is disposed at the lower open end of the bore 32, and the bore 32 is under the influence of

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the low pressure produced at the throat *g* of the carburetor. A cylindrical extension 33 projects upwardly from the center of the throttle body 3 and is received within the cylindrical wall 16 of the upper body 46 to assist in guiding the vertical movements of the throttle body and to house the preliminary mixing arrangement. The bore 32 passes through the extension 33 and at its upper end opens into a counter-bore of enlarged diameter in which a cylindrical air intake nozzle 7 is mounted. A needle valve 8 is also carried by the extension 33 of the throttle body 3 concentric with the nozzle 7 and within the latter. A fuel nozzle *x* includes a radial flange seating on the upper edge of cylindrical wall 16 and a depending cylindrical portion extending around the valve 8 in the space *k* defined by the air intake nozzle 7. A cover plate 48 is superposed on the radial flange of the nozzle *x* and the bore 35 opens at its upper end through a hole in this radial flange so that the fuel from chamber 5 passes through bore 35 above the flange of nozzle *x* and into a cavity 49 defined between the top of nozzle *x* and the cover plate 48. The fuel from cavity 49 flows downwardly through the annular space *u* defined between the needle 8 and the lower edge of the nozzle *x* and over a downwardly flaring conical portion *y* of the needle which has a sharp edge at its base. It is apparent that vertical movement of the throttle body 3 produces axial displacement of the needle 8 relative to the nozzle *x* and thereby varies the area of the annular space *u* to regulate the flow of fuel.

The air for preliminary mixing is supplied through a filter 10 secured on the top of wall 16 above the cover plate 48 and through a passage 13 formed in the cover plate and the radial flange of nozzle *x*. The air from passage 13 enters into a radial space between the top of air intake nozzle 7 and the lower surface of the radial flange at the top of nozzle *x*. At the top of air intake nozzle 7, an inwardly directed annular lip 67 is formed, and the outer surface of the cylindrical portion of nozzle *x* is bulbous, as at 34, so that the area of the annular space defined between lip 67 and the outer surface 34 varies as the throttle body 3 and the nozzle 7 are displaced vertically relative to the body 46 and the nozzle *x* to control the admission of air into the space *k* between the nozzles *x* and 7. The air passes through annular space *k* and mixes with the fuel which flows over the cone *y* and tears away from the sharp edged base of the latter. A throttling ring *z* surrounds the lower or base edge of the cone *y*, and the inside edge of ring *z* and the base of cone *y* define an annular slot *w* therebetween. The preliminary air-fuel mixture flows radially inward from the space *w* into an axial bore 63 formed in the lower portion of needle 8 and opening downwardly into the bore 32. It is apparent that the vacuum at *g* will be communicated through the bores 32 and 68 to the space *k* and that the differences in pressure between locations in space *k* and the pressure at *g* will vary as the throttle body is axially displaced to change the area of the annular space between lip 67 and nozzle *x*.

The lower portion of needle 8 having the axial bore 68 therein, is spaced from the wall of bore 32 so that an annular channel or vent 51 is formed therebetween. The vent 51 opens into a chamber 4 around the lower portion of the needle valve 8, and passages *o* are provided in the extension 33 and the cylindrical wall 16 for bringing air from the opening 13 to the chamber 4. Thus, air from chamber 4 passes through annular vent 51 to provide a further mixing of air with the preliminary air-fuel mixture as the latter emerges from bore 68 into bore 32. It should also be noted that the air delivered through the annular vent 51 provides a layer of air adjacent the wall of bore 32 so that the air-fuel mixture emerging from bore 68 flows through the bore 32 almost without coming in contact with the walls of the latter.

The parts described above in the arrangement for preliminary air-fuel mixing are dimensioned so that the annular slot for admitting air defined between surface 34 of nozzle *x* and lip 67 decreases in area when the throttle

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body 3 is displaced in the direction increasing the area of the annular slot u for regulating the fuel flow. This relationship, in conjunction with the action of throttle ring z , compensates for substantial variations in the low pressure at the discharge opening 50 at the lower end of bore 32. Further, the needle 8 has a contour, in the portion thereof cooperating with the lower edge of nozzle x to define the slot u , which is curved or shaped to conform to the fuel demand curve of the associated engine. The annular space k which is limited at the top by the lip 67 and varies in volume as the throttle body 3 is vertically displaced acts as an accelerator. That is, when the body 3 is suddenly moved upwardly, the volume of space k is increased to further lower the pressure therein so that the flow of a spurt of fuel is induced through the annular slot u to satisfy the sudden increased demand for fuel.

In order to permit movement of the throttle body 3 relative to the upper body 46, the space 36 between the bottom of the float chamber 5 and the interior of the throttle body is vented by a passage 37 which opens downwardly into the flow passage 2. Further, when the throttle body 3 is moved upwardly from the idling position, air flows out of chamber 36 through the passage 37 to avoid sticking of the intake pipe 1 to the body 3.

To provide for the delivery of an air-fuel mixture during idling, radial grooves 11 are formed in the surface of the throttle body 3 and communicate with passages L which open into the chamber 4 above the annular vent 51. When the body 3 is lowered to its idling position, the zone of lowest pressure shifts from a location at the tip 30 of the body 3 to locations in the passage 2 adjacent the grooves 11, so that the preliminary air fuel mixture then emerging from bore 68 travels upwardly through vent 51 into chamber 4 and thence through passages L for discharge at the grooves 11 into the air stream in flow passage 2. When the throttle body 3 is again raised, the area of low pressure shifts to the point 30 and the flow through passages L is then in the direction from the grooves 11 to the chamber 4. This additional air supply to the chamber 4 compensates for the reduced air intake through the annular slot between the lip 67 and surface 34 of nozzle x , since as previously mentioned the area of this slot decreases as the throttle body is raised and the area of slot u is increased.

The concave portion of the outer surface of throttle body 3 may be varied. For example, decreasing the radius of curvature of the concave portion produces a stronger radial flow effect and results in more economical utilization of the fuel, while increasing the radius of curvature reduces the change in direction in the incoming air stream in flow passage 2 and provides greater supply of fuel to the engine.

Referring now to Figs. 6 to 10, inclusive, a simplified carburetor primarily intended for a motorcycle and embodying the present invention is there illustrated. While the carburetor is shown in Figs. 6, 7 and 8 with the axis of the movable throttle body extending vertically, it is to be understood that the carburetor, when mounted on a motorcycle, is arranged so that the axis of the throttle body thereof is either horizontal or only slightly inclined relative to the horizontal with the right hand portion of the carburetor, as viewed in Fig. 6, being lowermost.

In the embodiment of Figs. 6 to 10, the flaring intake pipe 1, having an internal surface similar in shape to the surface d of Figs. 2 and 3, also forms the body or casing of the carburetor and is fixed to intake manifold (not shown) of an associated internal combustion engine by a split collar 1a at its converging end which is secured by a clamping bolt 1b (Figs. 6 and 7). Further, the side of the flaring intake pipe 1 to the left of Fig. 6 and which is uppermost in the installed position is formed to provide a rain shield. A cylindrical air filter 6 is disposed between the flaring intake pipe 1 and a cover 9, with axial bolts 31 (Figs. 9 and 10) being provided to secure together the cover 9 and pipe 1 with the filter 6

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clamped therebetween. The cover 9 is formed with a hollow structure depending therefrom to form a fuel filter chamber, and the fuel filter chamber defining structure has an arcuate outer wall portion and a chordal inner wall portion. A float valve chamber 5 is open at one side and at the top and is sealed at the open side and top by the cover 9. The outer walls of the structure depending from cover 9 to define a fuel filter chamber and of the float chamber 5 together form a cylindrical surface having a continuous helical thread 19 thereon (Fig. 8).

A throttle body 3 having an outer surface similar to the surface e of Figs. 2 and 3 is provided with a cylindrical recess opening toward the wide end of the body to receive the float chamber 5 and the fuel filter chamber of the cover 9. The cylindrical recess of body 3 is formed with a helical groove therein receiving the thread 19 so that rotation of the throttle body 3 will cause axial displacement thereof toward and away from the flaring intake pipe 1. Rotation of the throttle body 3 is effected in one direction by a Bowden cable 21 (Figs. 9 and 10) which enters the cover 9 tangentially to the thread bearing surfaces of the body 3 and the cover 9 and float chamber 5, and at the pitch angle of the threads. The cable 21 is received in a suitable groove 20 (Fig. 9) in the external surface of the float chamber 5 and connects to an attachment on the body 3 so that tension on the cable 21 causes the body 3 to rotate in one direction. A spring 22 is also connected to the cable attachment on the body 3 and to the float chamber 5 (Fig. 9) and acts to rotate the body 3 in the opposite direction when the tension in cable 21 is relaxed.

Fuel is admitted to the carburetor of Figs. 6 to 10 through a fuel line 29 which is coupled to a filter cap 28 threaded in the cover 9. A filter or cup-shaped screen 27 depends from the cap 28 and is received in the fuel filter chamber depending from the cover 9. Thus, fuel flows outwardly through the foraminated wall of the filter 27 into the surrounding fuel filter chamber. As seen in Fig. 9, a fuel passage leads from the fuel filter chamber to the float chamber 5 which contains a substantially semi-circular float 17, and a float operated valve 18 is interposed in the fuel passage leading from the fuel filter chamber to the float chamber. When the fuel level in the float chamber has reached a predetermined level, the float 17 engages valve 18 to close the latter thereby maintaining the fuel at the predetermined level.

The body 3 is formed with a discharge nozzle 30 at the vertex of the outer surface thereof, and the nozzle 30 communicates with a diametrically enlarged chamber 4 within the throttle body 3. A tubular extension 32 is fixed axially to the tubular body 3 and extends slidably and rotatably through a cylindrical member 16 which axially traverses the float chamber 5 and is fixed to the latter. A needle valve 8 and air intake nozzle 7 extend concentrically from the end of tubular extension 32, and a fuel nozzle x is carried by the end of cylindrical wall 16, the valve 8, and nozzles 7 and x cooperating in the manner described in connection with the embodiment of Figs. 4 and 5 to meter and effect initial mixing of the air and fuel mixture.

The air for initial or preliminary mixing of the air and fuel enters through a passage 13 (Fig. 10) and grooves 14 in the cylindrical member 16 forming the nozzle housing, and the admission of this air is varied in the manner previously described. Fuel for the preliminary mixing enters the arrangement described above through a bore 35 in the cover 9 extending from the fuel chamber 5. Additional air is mixed with the preliminary air-fuel mixture emerging from the tubular member 32 into the chamber 4 ahead of the discharge nozzle 30 through channels L which communicate with the high pressure zone of flow passage 2 through radial bores 11. Thus, under normal operating conditions, the pressure at 11 is higher than at the vertex nozzle 30 of the body 3, and

air flows through bores 11 and passages L into the chamber 4. When idling conditions prevail, the pressure at the bores 11 is less than the pressure at the discharge nozzle 30 and the air-fuel mixture flows from the chamber 4 into the passages L and is discharged from the bores 11, which then serves as atomizing nozzles.

In order to limit the rotational movement of the throttle body 3 in the direction causing idling, a stop 24, Fig. 7, is provided on the throttle body and is engaged by an adjustable abutment screw 23 extending tangentially through the intake pipe or body 1.

A rich mixture or additional fuel for starting is obtained with the carburetor of Figs. 6 to 10 by providing a plunger 26 (Fig. 10) which extends into the float chamber 5 and may be depressed against the action of a suitable spring to hold the float 17 out of engagement with the valve 18 even when the level of fuel has exceeded the predetermined level. When the plunger 26 is depressed as above, the float chamber 5 overflows through the passage 25 (Fig. 10) and the overflowing fuel splashes against the inner surface of the adjacent portion of the air filter 6 and surface atomization of the fuel is obtained for starting.

The carburetor illustrated in Fig. 11 is primarily intended for use as a motorcycle racing carburetor and, as in the embodiment of Figs. 6 to 10, the flaring intake pipe 1 is stationary and forms part of the carburetor body or housing rather than being movable in response to variations of vacuum in the intake manifold of the engine, as in the embodiment of Figs. 4 and 5. The flaring intake pipe 1 has an internal surface similar to the surface *d* of Figs. 2 and 3, and a throttle body 3, movable axially relative to the pipe 1, is formed with a concave substantially conical outer surface similar to the vertex portion of the surface *e* of Figs. 2 and 3. The periphery of throttle body 3 in Fig. 11 is extended to form an air scoop 80 curved in the direction toward the flared pipe 1 and operating to catch the air rushing past the carburetor and reverse the direction of movement of such air for radial feeding into the flow passage 2 of the carburetor thereby materially enhancing the suction effect of such radial flow.

The carburetor of Fig. 11 includes a fuel bowl 5 which has a cylindrical outer surface and extends slidably into a correspondingly shaped recess in the throttle body 3. Further, the fuel bowl 5 is provided with axially extending arms 75 which pass through suitable slots in the air scoop 80 and are bolted to the carburetor body 1. The bottoms of the fuel bowl 5 and the recess in the throttle body 3 receiving the fuel bowl define a relief chamber 36 therebetween, and a channel or passage 37 extends from the chamber 36 through the throttle body 3 to the flow passage 2 so that the pressure in chamber 36 is always the same as that in flow passage 2 and self-throttling of the carburetor is prevented.

A cover 9 is held against the rim of fuel bowl 5 by suitable fastenings (not shown). The arms 75 may be integral with the cover 9 rather than with the fuel bowl 5, as shown, and in that case the fuel bowl will be secured relative to the carburetor body 1 through the cover 9 and arms 75 rather than through the arms 75 alone. The fuel bowl 5 is formed with a central cylindrical wall extending axially therein to form a nozzle housing and the interior of the fuel bowl 5 is divided by suitable partitions into a float chamber at the lower side which accommodates a float 17 and communicates with a portion of the interior above the axial cylindrical wall having the fuel valve 18 therein. The float 17 is tiltable and acts to control the valve 18 so that the fuel in the float chamber is normally maintained at a desired level. The remainder of the interior of the bowl 5 forms a chamber H from which fuel is excluded. The throttle body 3 is formed with an axial extension which is slidable in the axial cylindrical wall at the center of the bowl 5, as in the previously described embodiments. In order to effect

axial movement of the throttle body 3 relative to the bowl 5 and the carburetor body 1, a shaft 70 is mounted in the chamber H and has two levers *r* rockably mounted thereon. One of the levers *r* extends at its outer end through an axial slot in the radially inward wall of the chamber H and into a recess 72 in the axial extension of the throttle body 3 so that rocking of that lever *r* produces axial movement of the throttle body. A Bowden cable 21 enters the cover 9 radially and connects to the other lever *r* which is also rockable on the shaft 70 and is secured to the first mentioned lever *r* by a cross-piece and bolts 71. A spring (not shown) acts on the assembled levers *r* to cause rocking in the direction moving the body 3 toward the intake pipe 1 and the Bowden cable 21 acts to cause opening movement of the throttle body.

The fuel is supplied through a pipe 29 connecting radially to the cover 9 and enters the float chamber through the valve 18. A fuel passage 35 is formed in the cover 9 for conveying the fuel from the float chamber to the structure effecting preliminary mixing of the air and fuel. This structure is of the kind described in detail in connection with Figs. 4 and 5 and includes an air intake nozzle and needle valve moving with the throttle body 3 and a fuel nozzle fixed relative to the cover 9 and cooperating with the air intake nozzle and the needle valve to control the admission of air and fuel, respectively, for the preliminary mixture. This preliminary mixture is discharged at the vertex of throttle body 3 from a nozzle 30 having a dispersing member P, and is led to the nozzle 30 through an axial bore 32 in the throttle body. The fuel fed into the space between the fuel nozzle and the needle valve enters from a space 49 in the removable portion 48 of the cover 9, and the air for the preliminary mixture is supplied through a passage 13 in the cover 9. The air for the preliminary mixture may be further controlled by a valve 76 in the passage 13 which is controlled by a separate Bowden cable (not shown) and acts as a choke to permit the use of an enriched mixture for starting and in cold weather. The carburetor of Fig. 11 is provided with grooves 11 in the surface of throttle body 3 having passages L extending therefrom to the preliminary mixing structure and with passages *o* extending from the chamber H to the preliminary mixing structure for supplying supplementary air for atomization and for discharging the idling mixture in the same manner as the correspondingly numbered parts on Figs. 4 and 5. A screw 23 extends through the body 1 to form an adjustable idling stop which limits the movement of the throttle body 3 toward the body 1, and another screw 78 extends through the cover 9 for engagement with the throttle body 3 to provide an adjustable stop for limiting the maximum size of the flow passage 2. The cover 9 also carries an adjustment screw 79 for controlling the admission of air for idling. The removable portion 48 of the cover 9 which has the fuel regulating nozzle secured thereto is preferably held in place by a leaf spring 77, and the cover portion 48 and the fuel nozzle may be easily removed for cleaning or replacement by removal of the spring 77.

The carburetor illustrated in Fig. 12 is also primarily intended for use on motorcycles and includes a body 1 forming a flaring intake pipe and a throttle body 3 which is movable axially toward and away from the internal surface of the body 1. As in the previously described embodiments, the confronting surfaces of the bodies 1 and 3 are similar in shape to the surfaces *d* and *e* of Figs. 2 and 3. A supporting body 54 is secured to the body 1 and includes an axially extending cylindrical member 66 which is slidable in a cylindrical recess of the throttle body 3 so that the axial movement of the latter is guided by the member 66. A spring 22 is interposed between the supporting body 54 and the throttle body 3 and continuously urges the latter in the direction toward the flaring intake body 1. A spindle 8, which in part forms a fuel metering needle, extends axially from the throttle

body 3 and is formed with an annular recess receiving a forked end of a lever 55 rockably mounted on the supporting body 54. A Bowden cable 21 is secured to the lever 55 and acts to rock the latter in the direction effecting axial displacement of the spindle 8 and body 3 toward the flaring intake body 1. A ring or stop 64 is mounted on the needle spindle 8 and is engageable against a portion of the support body 54 to limit the movement of the throttle body 3 under the action of the spring 22.

In order to adapt the carburetor of Fig. 12 for mounting at various angles to the horizontal, it includes a fuel bowl 5 which is pivoted on the support body 54 for swinging about the axis of a hollow shaft 60 through which the fuel is fed to the preliminary mixing arrangement. The pivotal mounting of the fuel bowl 5 permits the fuel therein to be maintained at the correct level with respect to the fuel metering structure for the various angles of mounting.

The carburetor of Fig. 12 includes controllable valve means for regulating the admission of air for preliminary mixing. Such air is admitted radially into a passage system 58 extending through the body 1 and support body 54, and a valve 57 is movable axially in the passage to vary the area of the air admitting opening. A spring acts on the valve 57 to yieldably urge the latter in the direction restricting the admission of air for preliminary mixing, and a Bowden cable 56 is also attached to the valve 57 for displacing the latter in the direction which increases the area of the air admitting opening. The passage system 58 connects to an opening 59 extending radially through the cylindrical member 66 of the support body 54.

The arrangement for preliminary mixing is similar to that described in connection with the embodiments of Figs. 4 and 5, 6 to 10, and 11, and the needle valve 8 is further provided with a vent 61 through which additional air for preliminary mixing is admitted when the throttle body 3 has shifted to its idling position so that the vent 61 has moved to a location outside of a guide bushing 62 which otherwise closes the opening 61. Thus, during idling additional air is provided to reduce the consumption of fuel during that operating condition.

While various embodiments of the present invention have been described and illustrated in detail, it is to be understood that the invention is not limited to these precise embodiments which are merely illustrative, and that various changes and modifications may be effected therein without departing from the spirit or scope of the invention as defined in the appended claims.

What is claimed is:

1. A carburetor for feeding an air-fuel mixture to the intake manifold of an internal combustion engine; said carburetor comprising a flaring intake pipe body for conducting the air-fuel mixture to the intake manifold of an associated engine, an onion shaped throttle body, means mounting said throttle body for axial movement relative to said flaring intake pipe, the confronting surfaces of said flaring intake pipe and said throttle body defining a flow passage therebetween which is adjustable in its minimum cross-sectional area by relative axial movement of said intake pipe and throttle body between a fully closed position in which said area is substantially zero and a wide open position in which said area is substantially equal to that of the associated intake manifold and is located at the tip of said onion shaped throttle body, said confronting surfaces of the flaring intake pipe and the throttle body being shaped so that, in said wide open position, said flow passage is bounded by hyperbolas corresponding to the curves of theoretical air flow acceleration whereas, in other positions between said wide open and fully closed positions, said flow passage is bounded by ideal flow curves which include hyperbolas of reduced dimensions followed by approximately ideal Venturi tube sections and then by approximately ideal Laval valve sections which widen to the area of the intake manifold, and

means at said tip of the throttle body for there discharging a fuel-air mixture into said flow passage.

2. A carburetor for feeding an air-fuel mixture to the intake manifold of an internal combustion engine; said carburetor comprising a flaring intake pipe member for conducting the air-fuel mixture to an intake manifold, a throttle body having a generally onion-like outer surface and aligned axially with said flaring intake pipe to define a flow passage between said outer surface of the throttle body and the inner surface of the flaring intake pipe for receiving air radially and for discharging an air-fuel mixture axially through said intake pipe, means supporting said throttle body and intake pipe for relative axial movement between fully opened and fully closed positions to vary the sectional area of said flow passage, the surfaces of said throttle body and intake pipe being formed so that the minimum cross-sectional area of said flow passage therebetween in said fully opened position is equal to that of the associated intake manifold and is located at the tip of said throttle body, said throttle body having means at the tip thereof for discharging a preliminary air-fuel mixture into said flow passage, and means regulated by movement of said throttle body for supplying a preliminary air-fuel mixture to said discharge means and for metering the air and fuel components of the preliminary mixture.

3. A carburetor according to claim 2; wherein said throttle body and flaring intake pipe are symmetrical about the aligned axes thereof.

4. A carburetor according to claim 2; further comprising manually actuatable means for effecting axial movement of said throttle body toward and away from said flaring intake pipe.

5. A carburetor according to claim 4; further comprising means supporting said flaring intake pipe for axial movement toward and away from said throttle body, and automatic means acting in response to the pressure at the outlet end of said flaring intake pipe for effecting axial movement of said flaring intake pipe.

6. A carburetor according to claim 5; wherein said means supporting the intake pipe includes a carburetor housing surrounding said intake pipe and defining a vacuum chamber opening axially against the peripheral portion of said flaring intake pipe in the direction facing toward said throttle body, said housing having a passage therein opening at its opposite ends into said vacuum chamber and adjacent the discharge end of said intake pipe so that the pressure in said vacuum chamber is substantially the same as that in the intake manifold of an associated engine, and spring means acting on said flaring intake pipe to yieldably urge the latter in the axial direction toward said throttle body for reducing the sectional area of said flow passage, whereby a relatively low pressure in the intake manifold of an associated engine causes said intake pipe to move axially away from said throttle body in opposition to said spring means for increasing the sectional area of said flow passage.

7. A carburetor according to claim 6; including a sealing membrane extending between the periphery of said flaring intake pipe and said carburetor housing for closing said vacuum chamber with respect to said flow passage.

8. A carburetor according to claim 7; including valve means in said housing passage operative to throttle flow of air in the direction from said vacuum chamber and to permit free flow of air through said housing passage in the direction toward said vacuum chamber.

9. A carburetor according to claim 2; further comprising means supporting said flaring intake pipe for axial movement toward and away from said throttle body, automatic means acting in response to the pressure at the outlet end of said flaring intake pipe for effecting axial movement of the latter, means for limiting the axial movement of said flaring intake pipe, and manually actuatable means for effecting axial movement of said

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throttle body through a range which is greater than the limited axial movement of said flaring intake pipe.

10. A carburetor according to claim 2; wherein said discharging means include a main discharge nozzle opening at the tip of said throttle body and said body further has auxiliary atomizer openings in the outer surface of said throttle body at the zone of said flow passage where the pressure changes from values in excess of atmospheric pressure to a vacuum.

11. A carburetor according to claim 2; wherein said flaring intake pipe includes a tubular outlet end portion and a convexly curved funnel portion which is dish-shaped at its periphery and connects smoothly to said tubular outlet end portion, and wherein said throttle body has a concave-conical vertex portion for protrusion into said funnel portion of the intake pipe.

12. A carburetor according to claim 10; wherein said means for supplying and metering the preliminary air-fuel mixture includes a stationary support, co-axial telescoping metering cylinders fixed to said support and to said throttle body, respectively, and defining an annular air metering slot therebetween, the inner one of said metering cylinders being shaped so that the area of said metering slot varies as said throttle body is moved axially relative to said stationary support; means for supplying air to said annular metering slot; fuel metering means for supplying regulated quantities of fuel for mixing with the air passing through said annular metering slot, and an axial bore in said throttle body extending to said main discharge nozzle for conveying the preliminary air-fuel mixture to said main discharge nozzle.

13. A carburetor according to claim 12; wherein said fuel metering means includes a fuel metering needle valve extending axially in said inner metering cylinder and movable relative to the latter in response to axial movement of said throttle body, said needle valve having different diameters along the length thereof and said inner metering cylinder and needle valve defining an annular fuel metering slot therebetween which varies in area in response to the axial movement of said throttle body, said needle valve being fully withdrawn from said inner metering cylinder when said throttle body is in said fully opened position, and means for supplying fuel to the space between said inner metering cylinder and said needle valve.

14. A carburetor according to claim 13; wherein said annular fuel metering slot is formed between the lower edge of said inner metering cylinder and said needle valve and said annular air metering slot is formed between the upper edge of the outer metering cylinder and said inner metering cylinder; and wherein said needle valve is formed with a conical portion below said lower edge of the inner metering cylinder, said conical portion having a sharp edge at the base thereof and a throttling ring extending around said base of the conical portion to define an annular throttling slot therebetween communicating with said axial bore of said throttle body so that the metered air is directed against said sharp edge of the conical portion to pick up the metered fuel flowing over the surface of the latter.

15. A carburetor according to claim 2; wherein said discharging means includes a main discharge nozzle opening at the vertex of said throttle body; and wherein said means for supplying and metering the preliminary air-fuel mixture includes a central axial projection on said throttle body extending in the direction away from said flaring intake pipe, a stationary cylindrical support around said central projection, said throttle body and projection having an axial bore extending therethrough to said main discharge nozzle opening and terminating in an enlarged diameter counter-bore at the end remote from said nozzle opening, an outer cylindrical metering member secured in said counter-bore, a fuel metering needle valve extending axially in said counter-bore and secured to said projection, an inner cylindrical metering member carried

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by said stationary support and extending axially into said counter-bore between said outer metering member and said needle valve, said outer metering member having an inwardly directed lip at the edge thereof remote from said main discharge nozzle opening and the outer surface of said inner metering member varying radially so that an annular air metering slot is defined between said lip and outer surface with the area of said slot varying in response to axial displacement of said throttle body, means for supplying air to said annular air metering slot, the edge of said inner metering member closest to said discharge nozzle opening being intumed so that an annular fuel metering slot is defined between said intumed edge and said needle valve, said needle valve varying in diameter along a portion of the length thereof so that the area of said fuel metering slot varies in response to axial displacement of said throttle body, and means for supplying fuel to the space between said inner metering member and said needle valve.

16. A carburetor according to claim 15; wherein said means for supplying fuel to the space between said inner metering member and needle valve includes a fuel bowl around said cylindrical stationary support, means for maintaining a predetermined level of fuel in said bowl, and passage means extending from said bowl to said space between the inner metering member and the needle valve.

17. A carburetor according to claim 16; wherein said needle valve includes a conical portion below said intumed edge of the inner metering member and having a sharp-edged base, and a throttle ring disposed in said counter-bore around said sharp-edged base so that the metered air impinges against said sharp-edged base to atomize the metered fuel flowing over said conical portion and provide a preliminary air-fuel mixture, said needle valve having an axial bore opening into said bore leading to the main discharge nozzle opening and radial passages extending from said axial bore of the needle valve and opening into the annular space between said throttling ring and said sharp-edged base for carrying the preliminary mixture to said main discharge nozzle opening.

18. A carburetor according to claim 17; wherein said axial projection of the throttle body has an annular cavity adjacent the end portion of said needle valve closest to said main discharge nozzle opening, an annular space around said end portion of the needle valve communicating said cavity with the axial bore leading to said main discharge nozzle opening, passage means in said throttle body extending from said cavity and opening at a location of relatively high pressure so that secondary air for atomization is normally supplied to said cavity for mixture with the preliminary air-fuel mixture at said end portion of the needle valve.

19. A carburetor according to claim 18; wherein said throttle body has auxiliary discharge nozzle openings in the outer surface thereof at locations which are subject to relatively low pressure when said throttle body is displaced toward said flaring intake pipe to the idling position, and passages in said throttle body extending between said cavity and said auxiliary openings so that the preliminary mixture is drawn from said needle valve bore into said cavity and discharged at said auxiliary openings when said throttle body is in its idling position.

20. A carburetor according to claim 19; wherein said auxiliary openings are located at different levels on said throttle body so that air enters the auxiliary openings subjected to relatively high pressure and the fuel-air mixture is discharged through the auxiliary openings subjected to relatively low pressure.

21. A carburetor according to claim 19; wherein said inner and outer cylindrical metering members are axially adjustable relative to said stationary support and said projection, respectively, for varying the relationship between the metering of the fuel and air and the position of said throttle body.

22. A carburetor according to claim 15; including an atomizer plate extending across said main discharge nozzle opening at the vertex of said throttle body and spaced axially from said vertex to effect dispersion of the fuel-air mixture issuing from said main nozzle opening.

23. A carburetor according to claim 15; wherein said means for supplying fuel to the space between the inner metering member and the needle valve includes a fuel bowl around said cylindrical support and having a cylindrical outer wall, said throttle body having a cylindrical recess opening in the direction away from said flaring intake pipe and receiving said fuel bowl, said throttle body having vent means extending between said flow passage and the space between the bottoms of said fuel bowl and said recess receiving the fuel bowl to prevent self-throttling of the carburetor.

24. A carburetor according to claim 2; further comprising air filtering means extending across the radially outward inlet end of said flow passage.

25. A carburetor according to claim 24; wherein said means for supplying a preliminary air-fuel mixture to said discharge means includes a fuel bowl, means operative to normally maintain fuel up to a predetermined level in said bowl, means for rendering the last mentioned means inoperative to cause over-flowing of fuel from said bowl, and passage means extending from said bowl above said predetermined level and opening adjacent said filter so that overflowing fuel is directed against said filter to wet the surface of the latter for additional atomization for starting.

26. A carburetor according to claim 15; wherein said means for supplying fuel to the space between said inner metering member and said needle valve includes a fuel bowl around said stationary cylindrical support and at an axial location between inner metering member and the vertex of said throttle body so that, when the carburetor is mounted on a vehicle with its axis horizontal and the throttle body having its vertex pointing in the direction of movement of the vehicle, the fuel will flow downwardly from said bowl to said space between the inner metering member and the needle valve during uphill driving of the vehicle.

27. A carburetor according to claim 26; including hollow shaft means pivotally mounting said fuel bowl on the stationary support, means conducting fuel from said pivoted bowl through said hollow shaft means to said space between the inner metering member and the needle valve, and means for maintaining fuel at a predetermined level within said pivoted bowl so that the level of fuel in said bowl always is the same in relation to said inner metering member and needle valve without regard to the angle at which the carburetor is mounted on a vehicle.

28. A carburetor according to claim 2; wherein said means supporting the throttle body includes a fixed housing having a cylindrical wall and enclosing a fuel bowl, said throttle body having a cylindrical recess re-

ceiving said cylindrical fixed housing and movable rotationally and axially on the latter, mating threads of steep pitch on the adjacent cylindrical walls of said recess and fixed housing, and manually actuatable means for effecting rotation of said throttle body relative to said fixed housing to thereby cause axial movement of said throttle body.

29. A carburetor according to claim 15; wherein said means for supplying fuel to the space between the inner metering member and the needle valve includes a fuel bowl around said stationary support, means for supplying fuel to said bowl, valve means for regulating the supply of fuel to said bowl, and a float member positioned in said bowl to actuate said valve means and free to tilt and to rise and fall within said bowl.

30. A carburetor according to claim 29; wherein said throttle body has a recess therein to accommodate said fuel bowl, and further including fuel filter means and a dirt trap chamber interposed in said means supplying fuel to the bowl and positioned in said recess of the throttle body.

31. A carburetor according to claim 30; wherein said fuel filter means and dirt trap chamber are included in a cover for said fuel bowl, and axially extending securing elements holding together said cover, said support member and the fuel bowl, and said support means for the flaring intake pipe.

32. A carburetor according to claim 31; wherein said securing elements consist of axial arms of elongated cross-section having the major axis of the cross-section extending radially to facilitate radial flow of air into said flow passage.

33. A carburetor according to claim 32; wherein said throttle body is substantially concave at the vertex portion thereof and includes a curved air scoop extending from the periphery thereof and facing in the direction toward said flaring intake pipe to direct air moving past the carburetor radially inward toward said vertex of the throttle body.

34. A carburetor according to claim 33; wherein said air scoop is formed with radial slots through which said axial securing arms extend.

35. A carburetor according to claim 2; wherein said throttle body has a vertex portion in the form of a chisel-like blade with said discharging means including discharge orifices opening along the edge of said blade-like vertex portion; and wherein said flaring intake pipe has an oval outlet portion with its major axis parallel to said edge of the vertex portion.

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