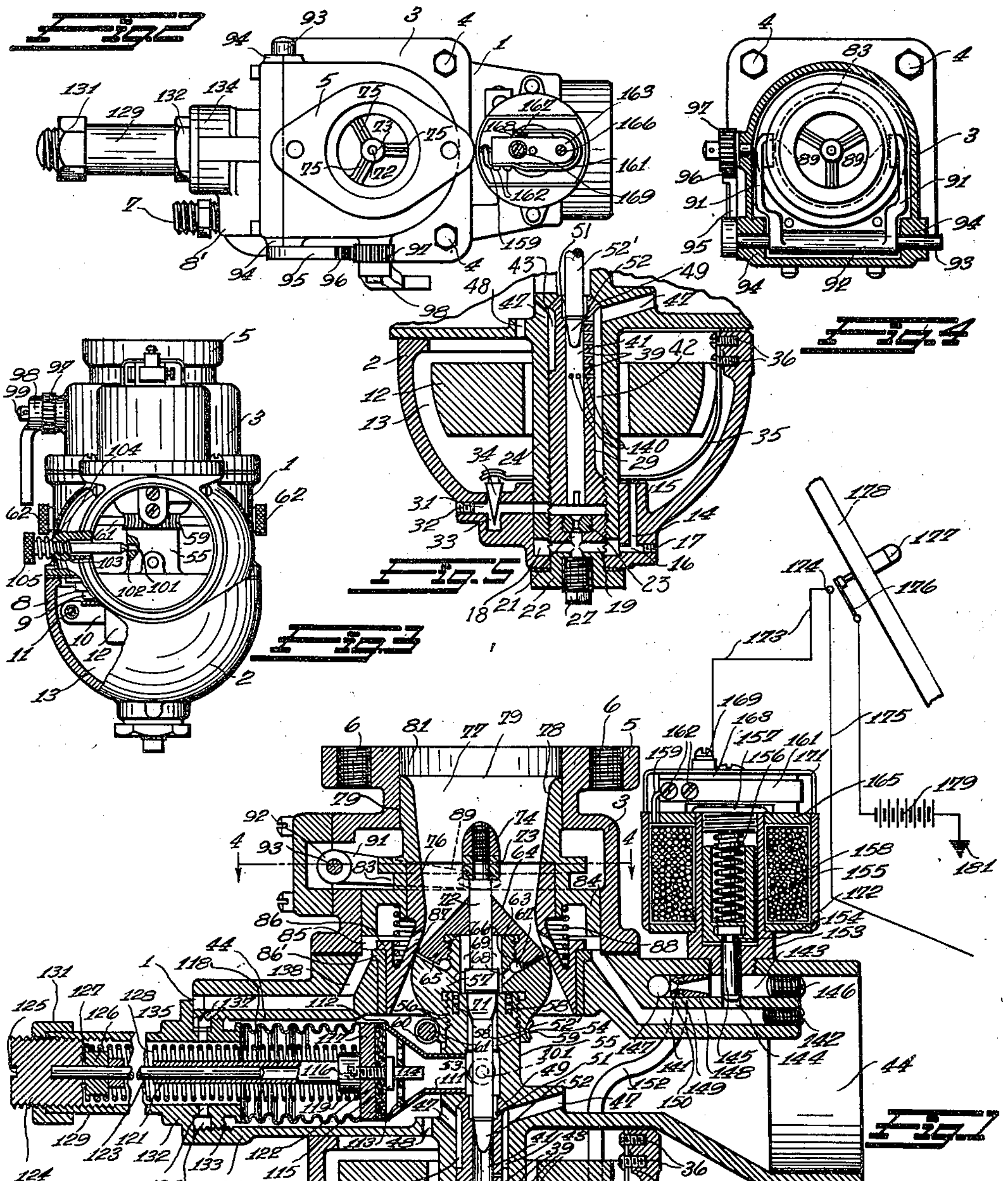
March 17, 1936. W. E. LEIBING ET AL 2,034,048

CARBURETOR

Filed Sept. 28, 1932 2 Sheets-Sheet 1



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Filed Sept. 28, 1932 2 Sheets-Sheet 2

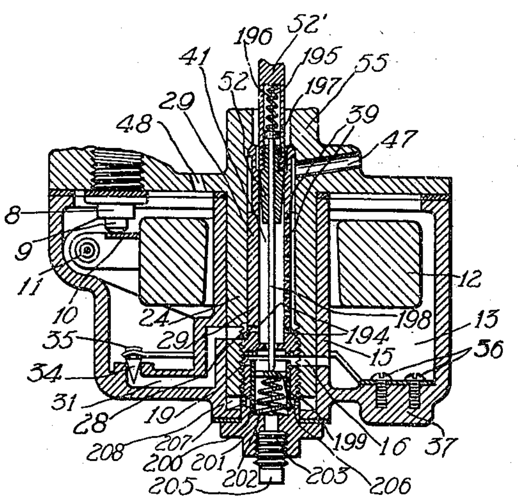

Fig. 6

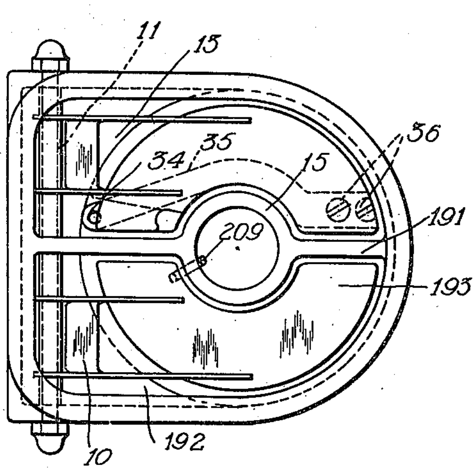

Fig. 7

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UNITED STATES PATENT OFFICE

2,034,048

CARBURETOR

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Application September 28, 1932, Serial No. 635,276

7 Claims. (Cl. 261—69)

Our present invention relates to novel carbureting apparatus.

More particularly our invention relates to novel apparatus providing effective fuel carburetion to secure and control mixtures adapted for complete combustion of fuel in internal combustion engines, and by the use of which the efficiency of operation of internal combustion engines when utilizing gasoline and the more volatile fuels is materially increased, while considerably heavier grades of fuel than are at present effectively available may be utilized if desired in the operation of the usual types of volatile fuel consuming automotive and similar internal combustion engines.

A primary object of the present invention is to provide an improved carburetor for gasoline and the more volatile fuels in which complete atomization of fuel and the formation of a homogeneous dry gaseous fuel mixture is secured adapted for complete combustion of the fuel mixture when the engine is doing useful work.

While many carbureting arrangements heretofore proposed have been provided with means to prevent the velocity of air passing through the carburetor venturi from passing below a predetermined minimum value; all such prior arrangements have utilized fixed venturi which permit the air velocity to drop materially from the predetermined minimum speed at the fuel jet with resultant loss of atomization of the fuel. Accordingly another object of our invention is the provision of a carbureting arrangement in which the ingoing air speeds at the fuel jet are maintained at a sufficient minimum velocity to secure thorough fuel atomization under all operating conditions.

As is now well known, when an internal combustion engine is being driven by its load or is operating at speeds substantially above idling speed with the throttle in idling position, incomplete combustion of fuel occurs with resultant discharge of unburned and noxious gases and smoke from the exhaust. Various forms of degassing mechanism have heretofore been devised to operate valves that cut off the fuel supply to the carburetor jets, or cut off the fuel mixture supply for the engine when the engine vacuum exceeds idling vacuum.

Another object of the present invention is to provide an improved and simplified degassing mechanism especially adapted for use with our improved carburetor, but the principles of which are applicable to other carburetors, and which arrests flow of fuel from the fuel jet or nozzle of the mechanism whenever the engine intake vacuum substantially exceeds the idling vacuum without utilization of a special cut-off valve mechanism in the fuel supply or between the carburetor and the engine.

Our improved carbureting apparatus is essentially a cold air carbureting device at low temperatures with the result that when started, engines supplied with fuel therefrom will operate efficiently without the necessity of being first warmed up with the engine partially choked as is now necessary. The velocity of the air flowing past the fuel nozzle is primarily relied upon, rather than heat, to secure fuel atomization in our improved apparatus. As a result at the low-engine cranking speeds and when the engine is cold, satisfactory atomization for starting purposes is not secured. Accordingly a further object of the present invention is to provide novel means to supply the engine when cold with a rich thoroughly atomized fuel mixture at cranking speeds and during cranking only, for starting purposes whereby the engine is started practically instantaneously and as soon as it is running, is supplied with an effective running mixture, while the starting mixture supply which is excessively rich for running is discontinued, thereby eliminating entirely the necessity for the usual choking operations with the resultant well known disadvantages and inefficiency due to choking.

We have found by experiment that heavier fuels such as stove distillate, kerosene, furnace oils, and like low cost nonvolatile fuels may be successfully used in internal combustion engines if they are properly atomized and if the engine compression ratios and speeds are properly maintained. Accordingly, it is another object of this invention to devise a carbureting arrangement which can be commercially utilized to take advantage of this discovery. Preferably, the arrangement will be such that different grades of fuel will be automatically selected during operation of the engine.

We have found in practice that the various standard carburetors in use on bus engines are so designed that surges of fuel induced by sudden stops of the vehicle disturb the fuel supply to the jets. In certain types a spurt of raw fuel is induced from the jets which causes waste of fuel and gassing. In other types the jets are robbed of idling fuel and cause the engine to stall. Accordingly, a further object of the present invention is the provision of carbureting mechanisms so constructed that the fuel supply to the engine is not disturbed by surges of fuel caused by sudden stops.

In the operation of commercial vehicles driven by internal combustion engines under modern traffic conditions, it has become desirable to apply speed limiting devices that will not limit the power of the vehicle for accelerating and operating purposes below the governed speed, but will provide a sharp power cut-off at the speed limit. Various forms of mechanical speed governing devices to control the fuel mixture supply to the engine are commercially available, all of which with the exception of the governing device shown in copending application S. N. 614,533 filed May 31, 1932, adversely limit the power output of the motors to which they are applied below the governed speed. The device shown in said copending application is a highly efficient governor that does not interfere with the power of the engine below governed speeds, and gives a sharp cut-off of power when the speed limit is reached, but may permit a richer fuel mixture than necessary for efficient operation at the governed speed to feed into the engine. Without the use of any added mechanism, we are enabled to control the supply of fuel mixture from our improved carburetor in accordance with engine speed in such manner as to give a reasonably satisfactory governing action without limitation in power in any way, but without the sharp power cut-off above governed speed secured by the governor disclosed in said copending application. By utilizing our improved mixture governor built into our carburetor with a mechanical governing arrangement giving a sharp power cut-off, and particularly with the governor shown in said copending application, and setting the mixture governor to govern to a speed slightly above and preferably at about 100 R. P. M. above which the mechanical governor is designed to operate, a substantial improvement in efficiency of the operation of governed engines at governed speeds is secured by assuring operation at governed speeds with a lean efficient mixture and cut-off of fuel at speeds of the vehicle substantially above the governed speeds.

Accordingly another object of the present invention is the provision of novel apparatus of governing the speeds of internal combustion engines.

A further object of the present invention is to provide novel means operable under changing throttle conditions in a carburetor, to change the fuel mixture ratios in advance of the throttle change, to provide a fairly rich fuel mixture to be delivered to the engine under accelerating conditions, and permitting the most economical fuel mixture to be utilized at all running positions.

A still further object of our invention is to provide novel apparatus for utilizing heavier fuels than gasoline in conventional spark ignited internal combustion engines.

Further objects of the invention will appear from the foregoing general discussion of the advantages of our invention, and the following detailed description thereof, and are such as may be attained by a utilization of the various novel principles, steps, combinations and subcombinations herein disclosed and defined by the scope of the appended claims in the various relations to which they are adapted.

Referring to the drawings:

Figure 1 is a vertical sectional view of an embodiment of our improved carbureting and fuel atomizing device designed for a single fuel.

Figure 2 is a plan view of the form of invention shown in Figure 1.

Figure 3 is an end view partially in section of the form of invention shown in Figure 1.

Figure 4 is a fragmental sectional view taken along line IV—IV of Figure 1.

Figure 5 is a fragmental sectional view illustrating the construction utilized to provide our improved mixture governing arrangement.

Figure 6 is a fragmental sectional view illustrating an embodiment of our invention adapted for the utilization of gasoline or volatile fuel, and stove distillate or a heavy fuel.

Figure 7 is a plan view of the fuel bowl and float chamber utilized in the form of invention shown in Figure 6.

As shown in Figures 1, 2, and 3, our improved carburetor comprises a body casting or housing **1** to which is removably secured a bowl casting **2**, in a manner that will more fully hereinafter appear, and a top casting **3** secured in place by cap screws **4**, forming a separable housing for our improved atomizing and carbureting device. Top casting **3** is provided with a securing flange **5** by means of which the device is connected to the intake manifold of an internal combustion engine through the use of screws that thread into suitable tapped holes **6** formed in securing flange **5**, (Figure 1).

Fuel is supplied to the device through a connection **7** (Figure 2) threaded into boss **8'** of casting **1** and passes through a suitable filter screen assembly of well known construction (not shown) to a float-operated needle valve assembly **8** of any well known construction threaded into casting **1**.

Valve assembly **8** comprises a float-operated valve member provided with an operating stem **9** actuated vertically by float bracket **10**. Float bracket **10** is pivoted at one end by means of pin **11** extending through suitable bearing holes formed in bowl casting **2**. Secured to bracket **10** is an annular float member **12** disposed in chamber **13**. The arrangement of the pivot for the float is preferably such that in operation when the brakes are applied to the vehicle the surge of fuel in the float chamber tends to close the float needle valve. Float **12** and valve assembly **8** function in well known manner to maintain a predetermined fuel level in float chamber **13**. Fuel from float chamber **13** passes downward through passage **14** formed in boss **15** of casting **2** and through cross passage **16**, of which one end is closed by a threaded plug **17**, into annular chamber **18**, and through passages **19** and **21** formed in plug **22** to metering bushing **23** screwed into the tapped enlarged end of fuel passage **21** in plug **22**. Plug **22** clamps bowl casting **2** in position and is screwed into the lower tapped end of a tubular well extension **24**, of main casting **1**, which extends through a central opening in float **12** and fits snugly into a cylindrical bore of boss **15** so that the lower end thereof forms the upper wall of chamber **18**. Bushing **23** is provided with a comparatively large metering passage **25**, the necessity for a small orifice being eliminated due to the fact that fuel is fed from float chamber **13** through passage **25** solely under the influence of gravity. A suitable drain plug **27** is threaded into a tapped drain hole formed in plug **22** for the purpose of draining the float chamber and fuel passages.

The upper end of passage **25** communicates with an annular chamber 28 formed between the upper end of plug 22 and the lower end of tubular fuel well member 29. Communication between chamber 28 and float chamber 13 is established through passage 31 closed at one end by screw plug 32, and by means of passage 33 closed by conical fuel metering valve member 34. Valve member 34 is mounted on and actuated by one end of bimetallic strip 35, the other end of which is fastened by screws 36 to a suitable boss 37 formed in bowl 2.

Well member 29 is threaded at its lower end and screwed into the suitably tapped lower end of tubular extension 24. A screw driver slot 38 is formed in well member 29 to receive a tool when the well member is inserted or removed.

Formed in the tubular well member 29 is a vertical series of lateral passages 39, which establish communication between the well chamber 41 of tubular member 29 and air slot 42 formed in the exterior of member 29. Communicating with the upper end of slot 42 is annular air channel or chamber 43 which communicates with main air passage 44 of main casting 1 through passageways 47 formed in casting 1.

Communication between the top of float chamber 13 and chamber or passage 44 is established by means of air passage 48, so that a balanced atmospheric pressure is maintained on top of float chamber 13 and over the fuel in well chamber 41. thereby insuring that fuel flows from the float chamber to the fuel well solely under the influence of gravity, and eliminating the necessity for a small metering orifice in member 23, thereby eliminating the tendency present in existing carburetors, of separating complex modern fuels into their constituents, due to forcing the fuel through small metering orifices under heavy pressure differences.

Formed integrally with the upper end of tubular member 29 is a head 49 which nests against a suitably formed conical recess in main casting 1. Head 49 is counterbored at 51 to provide a metering valve seat with which metering valve member 52 is adapted to cooperate to vary the opening for the passage of fuel and air mixture out of the top of well chamber 41 in accordance with the varying fuel mixture requirements of the engine for which the device is designed. Metering member 52 is formed integrally on the lower end of stem 52′ which extends upward through bores 53 and 54 formed in the nozzle supporting tubular extension 55 externally threaded at 56 to receive and adjustably support suitably tapped lower fuel nozzle member 57. The upper end of a helical compression spring 58 nested in a groove 58′ of extension 55 engages the upper wall of tapped bore of member 57 to hold member 57 yieldingly in adjusted position. Formed on nozzle member 57 is a worm gear 59 (Figures 1 and 3) which meshes with a worm wheel 60 formed on an operating shaft 61 the ends of which are in suitable bearings (not shown) of casting 1 and provided at its opposite ends which protrude outward through said bearings with knurled adjusting heads 62.

By rotating heads 62 and shaft 61, the entire nozzle assembly carried by member 57 may be adjusted with relation to the throttle control member to establish idling adjustment in a manner that will more fully hereinafter appear.

Nozzle member 57 has formed integrally therewith threaded nozzle tip member pilot extension 63 upon which the nozzle tip member 64 is screwed. Nozzle members 57 and 64 are provided respectively with conical surfaces 65 and 66 spaced apart to form a fuel mixture outlet channel from the nozzle assembly through which a conical sheet of fuel mixture or air fuel emulsion is fed into the air stream drawn through the carburetor in a manner that will more fully hereinafter appear. The separation of surfaces 65 and 66 may be varied by adjusting tip member 64 on threaded supporting shank 63.

The spacing or separation of surfaces 65 and 66 and the length of the fuel ejecting passage or channel formed thereby form important features of the present invention. The spacing arrangements should be such that a rolling turbulence or intimate mixing effect occurs on the fuel as it passes between surfaces 65 and 66, and a directional effect is imparted to the fuel mixture flowing from the nozzle in operation, so that a conical sheet of fuel mixture in the form of an intimate mixture or emulsion of air and fuel is fed substantially at right angles into the air stream passing the nozzle assembly. A passage length of approximately three-eighths of an inch, and a thickness of 0.005 to 0.012 of an inch have given excellent results in practice in a carburetor utilized on a La Salle car, the preferred spacing being approximately 0.010 of an inch.

The fuel passages formed between surfaces 65 and 66 terminate in an annular distribution chamber 67 connected by passages 68 formed in the base of threaded extension 63, to chamber 69 formed in extension 63, and which communicates with the upper end of bore 54 of tubular extension 55. The opening between chamber 69 and bore 54 is controlled by the position of metering valve member 71 formed integrally with stem 52′. Member 71 is formed integrally with a stem 72 the upper end of which is reduced in diameter and extends through and is secured to boss 73 by means of nut 74. Boss 73 is rigidly secured by means of ribs 75 (Figure 2) to lower half 76 (Figure 1) of a control tube assembly.

Air passing by the nozzle is drawn through the usual air cleaner into passage 44 and the flow past the nozzle assembly is controlled by control tube assembly having a control passage 77. The control tube assembly is provided with an upper manually controlled section 78 having a cylindrical surface 79 which fits slidably into bore 81 of upper housing casting 3. Formed integrally with section 78 is an annular shouldered section which serves as a stop for the upward vertical movement of section 78, and spaced therefrom and forming annular groove 83 is cylindrical skirt piston 84 which fits slidably into bore 85 of top casting 3. The upper cylindrical end section 76 fits slidably in a complemental shouldered central bore formed in section 78. Formed integrally with control tube section 76 is a cylindrical or trunk piston extension 86 which fits slidably in a bushing 86′ pressed in a bore formed in housing section 1. Communication between the engine side of the nozzle assembly in passage 77 and the space between pistons 84 and piston 86 is established by means of passages 87 to establish engine manifold pressures between the pistons in operation. A spring 88 interposed between pistons 84 and 86 normally tends to separate the pistons and control tube assembly sections 76 and 78 with a light pressure so that a predetermined velocity of air, sufficient to maintain complete atomization is necessary to compress spring 88 sufficiently to bring sections 76 and 78 together. For the atomization of fuels such as gasoline a spring that requires about one inch vacuum between the pistons 84 and 86 to bring sections 76 and 78 together when section 78 has been moved to its upper or wide open position has been found sufficient to maintain atomization under all conditions of operation, in the manner that will more fully hereinafter appear, while for heavier fuels such as stove distillate a spring requiring a two inch vacuum between the pistons to bring the control sections 76 and 78 together has been found satisfactory. The stiffness of spring 88, it is to be understood, will be varied for different fuels and with different engines to maintain atomization when control section is moved suddenly to open position, as frequently happens in operation. The strength of spring 88 is, however, by no means critical, as a wide range of spring strength will give satisfactory operation. The position of control tube 78 with relation to nozzle assembly in operation of the device is controlled by means of hardened curved actuating members 89 (Figures 1 and 4) which fit into annular groove 83. Members 89 are formed integrally with arms 91 of yoke 92, which is rigidly secured to operating spindle 93 suitably journalled for rotation in bosses 94 of casting 3. Any suitable actuating mechanism may be provided for rotating spindle 93 as for example arm 95 secured at one end to a projecting end of the spindle and provided at its other end with arcuate toothed rack 96 meshing with pinion 97 rigidly secured to operating arm 98 which is journalled on spindle 99. Operation of arm 98 results in vertical displacement of the tube 76 with respect to the nozzle assembly in a manner that is apparent to those skilled in the art.

Proper proportions of spring 88 and the shape and arrangement of passage 77 which extends through control tube sections 76 and 78 with respect to the fuel nozzle are important to secure complete atomization of the fuel mixture throughout the range of operation of the device. The strength of spring 88 should be selected as pointed out to maintain atomizing velocities for the particular fuel used when section 78 is moved to open position suddenly, and passage 77 should be shaped and proportioned with respect to the fuel nozzle assembly so that in all conditions of operation a sufficiently high velocity of flow of air through passage 77 will be maintained for a sufficient length of time to cause sufficiently fine division of fuel particles fed into the air stream from the nozzle so that they will remain in suspension for substantial periods even when the velocity of flow is arrested or suddenly reversed in an engine manifold. If the requisite velocity is not maintained for a sufficient distance, a wet fuel mixture results from which the fuel will settle or be thrown out in the intake manifold, more or less of the type of mixture produced by prior carburetion systems, so that heat must be applied to the manifold to secure a proper combustion of mixture in the engine.

The relationship of velocity and distance of flow necessary to produce my novel dry gas fuel mixture suitable for cold air carburetion varies with the size of the carburetor utilized, depends upon the nature of fuel and degree of volatility of the nozzle design and other engineering factors, since the establishment of an excess velocity and length of flow over the minimum values required is beneficial as the higher velocities and lengths of flow are required for the heavier fuels, and a carburetor designed to produce my improved dry gas mixture with a heavier fuel, will function properly with the lighter fuels, so that by designing the carburetors properly, a wide range of fuels may be utilized in a given motor vehicle.

Furthermore, since the velocity of air flow through passage 77 is decreased as the throttle opening is increased, and is at a minimum at the widest throttle opening, by designing the control tube so that sufficient velocity and length of flow exists with the throttle or control tube 77 in wide open position to secure complete atomization, desirable fine division or atomization of fuel will be secured throughout the entire range of operation of the carburetor from wide open to idling condition. It is to be here noted that the arrangement whereby an intimate mixture or emulsion of air and fuel is fed from the nozzle into the air stream in control passage 77 is an important aid in securing atomization or apparently colloidal division of fuel particles, particularly of the heavier fuels utilized, apparently due to the sudden expansion of the intimately mixed air as the mixture leaves the nozzle. The specific shape and proportions of control passage 77 and the nozzle for a La Salle pleasure car are given in detail in copending application Serial Number 543,427, which has matured to Patent No. 1,990,702 granted Feb. 12, 1935.

Under normal operating conditions, the effect of spring 88 is overcome and sections 76 and 78 of the control tube assembly are held together by the effect of the velocity of air flowing through passage 77 of the tube assembly, and the throttle opening past the nozzle assembly is determined by the vertical position of the accelerator tube section 76. The positions of metering members 52 and 71, which determine the richness of the fuel mixture, it will be noted, will be determined by the position of control tube 76 for the purpose of varying the relative proportions of fuel and air fed to the fuel nozzle for various throttle positions, thereby varying the richness of the fuel mixture to meet the varying engine requirements at different throttle openings and under varying load conditions. Since the maximum velocity of air flow in passage 77 occurs while control tube 76 is in its position of minimum opening or idling position, and the minimum velocity of flow occurs past the fuel outlet with the control tube in wide open throttle position, the maximum suction effect on the nozzle occurs in idling position. However, with control tube 76 in idling position it will be seen that valves 52 and 71 are in their lowermost positions establishing a minimum area for fuel mixture passage from well 41 to the nozzle. On the other hand, with the throttle in wide open position valves 52 and 71 are in their uppermost positions permitting a maximum flow of fuel mixture to the nozzle from the well.

In operation at idling speeds, idling intake vacuum exists above member 72 and the parts are so adjusted that about one-half inch of vacuum exists between members 52 and 71, the two metering members being provided to give more accurate control of the fuel mixture than can be secured with a single metering member.

When the accelerator is operated suddenly to impart an opening movement to the accelerator section 78 of the control tube assembly, section 76 which rides the air stream past the nozzle assembly will lag behind section 78, under the influence of spring 88 and will restrict the opening around the nozzle assembly sufficiently to maintain an atomizing velocity of the air stream past the nozzle until the engine accelerates to the point where the effect of the air stream on section 76 is sufficient to overcome spring 88 and to raise section 76 into collapsed position with relation to section 78. When sufficient air velocity is present to overcome spring 88 and hold tube sections 76 and 78 together, the air velocity past the nozzle assembly is always sufficient to maintain atomization of the fuel. In this way it will be seen that the minimum ingoing velocity of air at the fuel jet or nozzle is sufficient under all operating conditions to maintain fuel atomization.

To secure idling speed adjustment, the vertical position of the nozzle assembly is adjusted with relation to the control tube assembly by means of adjusting heads 62 as above pointed out. To secure idling mixture adjustment an air inlet opening 101 is provided between metering control members 52 and 71 in tubular extension 55 which is controlled by the conical end of idling adjusting valve member 102 (Figure 3). Valve member 102 is adjustably supported on a suitably threaded section 103 in a tapped hole formed in main casting 1, and is held in adjusted position by a spring 104 which abuts against knurled adjusting head 105 thereof. By adjusting the position of valve member 102 the amount of air leakage from passage 101 may be varied to vary the richness of the idling mixture drawn through chamber 54 from the fuel well.

A built in fuel economizer and gas eliminating mechanism is preferably provided, operative when the control tube assembly is in idling position and the engine intake pressures in passage 77 on the engine side of nozzle assembly drop below normal idling pressure, to cut off the fuel mixture flow to the nozzle thus materially increasing the efficiency of the engine supplied with fuel by our improved carbureting devices, and eliminating the discharge of noxious gases and unburned fuel that normally occur when the load is driving an internal combustion engine. It will, however, be understood by those skilled in the art that the built in economizer may be eliminated if desired as the carbureting mechanism so far described is operative without our built in economizer.

As shown in Figure 1, an opening 111 is provided between metering members 52 and 71 into which funnel member 112 is pressed. A perforated guide member 113 is secured in funnel 112 bored centrally to slidably receive valve guide extension 114.

Guide extension 114 is provided with a collar section 115 and a threaded extension 116 which is threaded into the metallic wall 117 of resilient metallic bellows member 118 and into base 119 of a tubular central guide member 121 for the bellows. A fibre valve member 122 for the mouth of funnel member 112 is clamped in position between bellows wall 117 and collar 115. Extending slidably into tubular guide member 121 is a guide pin 123 one end of which is rigidly secured in adjusting screw plug 124 provided with a screw driver slot 125 for adjusting purposes. Mounted on guide pin 123 for relative rotation is a spring thrust member 126 which abuts against anti-friction balls 127 mounted in a suitable groove formed in the end of screw plug 125. A compression spring 128 interposed between thrust member 126, and wall 117 of the resilient bellows 118 surrounds tube 121 and guide pin 123, and resists the tendency of bellows 118 to retract valve 122 in operation in a manner that will more fully hereinafter appear.

Screw plug 124 is threaded into the tapped end of tubular member 129 and is locked in position by means of the threaded locking collar 131. Tubular member 129 is provided with a flanged nut section 132, and threaded plug section 133 which screws into the tapped section 134 of casting 1 in which the bellows assembly is mounted. Bellows 118 is rigidly secured to the inner end of plug 133 by soldering or in any other suitable manner.

Communication with the interior of plug member 133 and the interior of the bellows is established through passages 135 to an annular chamber 136 formed by means of an annular groove cut into plug 133. Communication from chamber 136 is established through passages 137 and 138 in main casting 1 to the space between pistons 84 and 86 of the control tube assembly, which in turn is connected to the engine side of the nozzle assembly, so that engine intake manifold pressures are established at all times in the interior of bellows 118, and so that when the intake pressures on the engine side of the control tube assembly go below normal idling pressures bellows 118 will contract and will unseat valve 122 from funnel 112 permitting a large volume of air at atmospheric pressure from passage 44 to enter chamber 53 between metering valve members 52 and 71.

When the engine is idling or is doing useful work, the engine intake pressures will be equal to or above normal idling pressures, and under such conditions the parts will remain in the position shown in Figure 1. When, however, the load drives the engine with the control tube assembly in idling position, as for example during deceleration of the engine, the pressure in passage 77 on the engine side of the nozzle drops below the normal idling intake manifold pressure, and the proportion and adjustment of parts is such that tendency of bellows 118 to contract will overcome the compression of spring 128 sufficiently to unseat valve face 122, and the resultant air flow through funnel 112 into chamber 53 will cut off the fuel supply completely from the nozzle, and air will be drawn from chamber 53 to the nozzle.

In operation the nozzle assembly is adjusted with relation to control tube assembly and valve member 102 is adjusted in the manner above set forth to establish a proper opening and fuel mixture for idling purposes. Plug 124 is adjusted with control tube assembly in idling position so that the compression of spring 128 will just overcome the tendency of bellows 118 to contract and valve member 122 will be held against and will seal the mouth of funnel member 112. When the pressure in the control passage 77 on the engine side reaches normal idling pressure bellows 118 again expands, and with the control tube in idling position valve 122 will be seated against the end of funnel 112 and idling fuel mixture will again flow to the nozzle assembly from well 41 with no perceptible lag in the fuel supply.

In addition to the variation of the proportions of air and fuel secured by operation of valves 52 and 71 with the position of the throttle and movement of the control tube assembly, the relative proportions of air and fuel are varied automatically in accordance with variations of the engine in given throttle positions by the arrangement shown.

With the engine turning over at high speed in any given throttle position a balance of fuel level in well 41 will be established which will result in a predetermined amount of air being drawn through openings 39 in the well tube 29 and mixed with the fuel passing upward into chamber 53. If the engine slows down with the throttle in the same position, due for example to an increase in grade or other road conditions met by the vehicle, the suction effect of the engine on the carburetor will be reduced, and the fuel level in well 41 will rise reducing the number of holes 39 through which the air may pass into chamber 41. A larger proportion of fuel and less air will accordingly be drawn from well 41, with the result that a richer fuel mixture will be supplied to the nozzle to assist the engine in carrying the increased load, and a new position of fuel level and balance will be established in the well 41.

As the load on the engine decreases, as for example, when a vehicle reaches the top of a grade, the engine speeds up, an increased volume of air will be drawn through the carburetor increasing the velocity of flow past the fuel nozzle and as a result increasing the suction on well 41. the increased suction on well 41 will result in a lowering of the fuel level until a new balance is established.

In this way it will be seen that the fuel mixture supplied to the nozzle is varied in richness in accordance with throttle position as well as engine speed, and all fuel is cut off during deceleration, providing highly efficient operation and most effective fuel mixtures throughout the entire operation of the engine.

By substituting for the well member 29, a member of the construction illustrated in Figure 5, in which the vertical series of air inlets 39 extend downward from the top of the member 29 a distance corresponding to the level in well 41 to which the fuel drops when the engine is operated at a speed at which it is desired to effect governing, and at this level adding a horizontal series of air holes 140. When the fuel in the well reaches the level of the holes 140 an excess volume of air will be taken into well 41 through holes 140, and only sufficient fuel mixture will be supplied to the nozzle assembly to drive the engine at the speed determined by the level of holes 140. The maximum engine speed will accordingly be held to a definite predetermined value. In this way an effective governing action is secured which, while not as sharp as that secured by the mechanical governor disclosed in said copending application, is satisfactory for certain commercial purposes.

When our improved carburetor is used in combination with a mechanical governor of the type shown in said copending application set to operate at a speed slightly below the maximum speed permitted by utilization of the governing arrangement illustrated in Figure 5 a very efficient governing action is secured with lean mixtures at the governed speeds, making a highly desirable combination where sharp governing of the engine speeds to a predetermined maximum speed without loss of power and efficiency is desired.

While the usual methods of choking our improved carburetor by restricting the amount of air entering into well 41 through openings 47 as illustrated in said copending application S. N. 543,427 may be utilized for starting purposes as will be apparent to those skilled in the art, our invention comprises the improved mechanism and methods now to be described in detail, by means of which a thoroughly atomized fuel mixture is supplied to the engine at cranking speeds when the engine is cold.

To incorporate our improved starting device in the form of invention shown in Figure 1, the starting mixture is fed through duct or passage 141 formed in casting 1 to the space between the control tube assembly pistons 84 and 86 and passes through the openings 87 into control tube passage 77 above the fuel nozzle assembly. The outer end of passage 141 is closed by a screw plug 142, and passage 141 communicates with a chamber 143 through opening 144 which is controlled by valve member 145. One end of passage 143 is closed by a screw plug 146 and the other end communicates with air intake passage 44 through opening 147. Located in chamber 143 between valve 145 and the atmospheric opening 147 is a small Venturi tube 148 provided adjacent its throat with an external fuel groove 149 which communicates through a series of small openings 150 with the Venturi throat. Communication between annular exterior groove 149 of tube 148 with the fuel in float chamber is established through a small tube 152.

Valve 145 is guided for vertical motion in a solenoid supporting member 153, preferably of non-magnetic metal, which is threaded into a suitable bore formed in main casting 1. The upper end of valve member 145 is provided with a grooved section 154 into which suitable securing prongs of the solenoid plunger 155 of magnetic material fit so that valve member 145 is actuated by the solenoid plunger 155. Solenoid plunger 155 is slidably mounted in a tubular extension of supporting member 153, and is normally urged downward by the action of compression spring 156, the lower portion of which nests in and abuts against a shoulder bore formed in plunger 155, and the upper end of which abuts against a screw plug 157 provided with a guide extension projecting into the upper end of the spring 156, and which is threaded into and closes the upper end of the solenoid receiving bore in supporting member 153. Supported by and surrounding member 153 is a solenoid coil 158, one terminal of which is grounded, and the other terminal of which is connected by a wire 159 to the end of a bi-metallic thermostatic contact spring member 161 secured by screws 162 to a suitable fiber insulating block 163. Block 163 is secured to the top plate member 165 by screw 166 or in any other suitable manner. Contact spring 161 carries and actuates a contact 167 (Figure 2) which is adapted to engage a contact 168 carried by a fiber block 163. Contact 168 is connected by a suitable conductor to the binding post 169 on block 163. Suitable covers 171 and 172 for the contacts and solenoid coil are provided. Binding post 169 in operation is connected by suitable conductor 173 to the motor vehicle starter contact 174. A lead 175 from contact 174 is connected in series with the engine starting motor. Contact 174 is connected by means of the spring contact 176 and the usual starter button 177 located on the floor board 178 of the vehicle, to battery 179 which is grounded at 181.

In operation, when the carburetor is cold, bimetallic contact strip 161 operates to hold contact 157 and 158 in engagement completing a circuit from contact 174 through coil 158 to ground. When the carburetor is warm with the engine heated contacts 167 and 168 are separated by expansion of spring 161 and solenoid 158 can not be energized.

With the carburetor cold and contacts 167 and

168 closed when starter button 177 is depressed, the starting motor will be energized from battery 179 through lead 175 and the solenoid 158 will simultaneously be energized through the circuit completed by lead 173 and closed contacts 167 and 168. Energization of the solenoid coil 158 will result in raising of plunger 155 against the compression of spring 156, and will raise valve member 145 opening passage 144 to establish communication from the engine manifold through passage control tube openings 87, the space between pistons 84 and 86 and duct 141. With the control tube assembly in closed throttle position, cranking the engine at comparatively low speeds will induce a substantial suction in passages 141, and 144, and will draw air at high velocity through the small opening 147 and the interior of venturi 148. The velocity of the air passing through venturi 148 is increased in well known manner at the throat of the venturi, with the result that a substantial suction is created through the opening 151 on annular chamber 149 which results in drawing fuel through tube 152 from the interior of the carburetor bowl 13. The fuel drawn up through tube 152 into the venturi 148 through openings 151, is thoroughly atomized due to the high velocity of air passing through the Venturi section, and a very rich atomized fuel mixture is drawn through passages 144, 141 and 87 into the passage 77 where it mingles with the idling air and supplies a very rich, thoroughly atomized starting mixture to the engine.

The starter button 177 is released upon starting of the engine, the circuit to solenoid 158 is then broken at contacts 174 and 176 and spring 156 becomes operative to force solenoid 155 and valve 145 downward closing opening 144 and cutting off the fuel mixture supply and air flow through venturi 148. The engine which will then be operating at idling speeds, will then receive a proper supply of fuel mixture for operating purposes from the fuel nozzle assembly.

The supply of fuel to the nozzle assembly is augmented while the carburetor is cold and warming up by operation of the thermostatically controlled valve 34, which is in open position when the carburetor is cold, permitting fuel to enter well 41 through supplemental passages 28 and 31. As the engine heats up, valve 34 is gradually closed reducing the fuel supply through the passages 28 and 31, and when the engine is heated to proper running temperatures valve 34 is completely closed. The fuel supplied from the carburetor then passes into well 41 entirely through the metering bushing 23 until the carburetor again becomes cold enough to cause opening of valve 34, when additional fuel is supplied in the manner above set forth. So long as the engine temperature is sufficient for satisfactory starting and operation with the normal fuel supply from the nozzle assembly, contacts 167 and 168 will remain open and valve 34 will remain closed.

Our improved starting mechanism, operative when the engine is cold, is highly effective and assures proper mixtures for starting at cranking speeds, and eliminates the necessity for choking completely, with the resultant elimination of crank case dilution, other disadvantages, and fuel waste incident to the choking necessary with the conventional types of existing carburetors.

The detailed operation of the various sub-combinations of parts of the device shown in Figures 1 to 3 having been hereinbefore described, a general description of operation will now be given.

A predetermined fuel level is maintained in float chamber 13 by operation of the float controlled valve assembly 8 and fuel flows from chamber 13 through metering orifice 23 at a rate determined by the difference in fuel level in well 41 and in chamber 13. Owing to the fact that substantially equal atmospheric pressures are maintained on the fuel float chamber and in well 41 through communication with passage 44, the flow of fuel to well 41 is under the sole influence of gravity, and the rate of flow is determined by the rate of fuel consumption.

The positions of valves 52 and 71 determine the relative amount of fuel and air passing from well 41 to the fuel nozzle assembly. Since the positions of valves 52 and 71 are determined by the throttle position in normal operation, the richness of the mixture will be dependent upon the throttle position as well as the speed of operation of the engine as hereinbefore set forth in detail. Fuel vapors passing from the float chamber will be drawn into passage 77 from passage 44. The proper fuel supply for each given engine condition, in passing through chambers 41, 53 and 69 and out of the fuel outlet, is intimately mixed with the air and reduced to a state of an emulsion of fuel and air, the final mixing occurring in passing out through the fuel passages between surfaces 65 and 66 of the nozzle.

Air drawn through the usual cleaner and through intake passages 44 by the suction of the engine flows past the nozzle into control passage 77, and because of the pressure difference between the atmospheric side and the engine side of the fuel nozzle, passes the nozzle at high velocity throughout the entire range of the control tube positions from idling to wide open position. At wide open position in which the velocity of flow past the nozzle is lowest, due to the shape of passage 77 the velocity of flow is increased for a substantial distance beyond the nozzle outlet. Due to the circumferential length of the fuel nozzle and the comparatively small space between the walls of passage 77 and the edge of the fuel nozzle outlet, a very intimate contact of the ingoing air streams with the fuel emulsion emitted from the nozzle outlet is secured. This results in minute particles or ribbons of fuel being torn from the fuel mixture or emulsion being projected from the fuel nozzle at approximately right angles to the air stream due to the comparatively lower pressures in passage 77 during operation.

As the particles of fuel emulsion leave the fuel nozzle and enter the air stream, the air in the emulsion expands due to the lower pressures outside of the nozzle tending to atomize the fuel, and the particles are caught in the air stream and carried at sufficiently high velocity through all operating positions of tube 76 for a sufficient distance to reduce the particles of fuel to a sufficiently fine division so they will remain suspended in the air, forming what appears to be a suspension of colloidally divided fuel in air. The fuel mixture produced in this way is a homogeneous dry gaseous mixture of fuel suspended in air in a form that will give effective uniform and complete combustion in the cylinder of an engine without development of detonating pressures.

With the fuel well 41 centrally arranged in circular float chamber 13 and float 12 supported in such manner that with the mechanism in position on a vehicle, sudden stopping of the vehicle causes the resultant fuel surge to actuate float 12 to close needle valve 9, the level of fuel in the float chamber is not altered due to excess fuel admission during surges as occurs in the various carburetors at present on the market, and the effect of fuel surges in float centrally arranged chamber on the supply of fuel to well 41 is negligible, giving a considerably improved operation for motor vehicles with our improved carbureting apparatus, due to the effect of elimination of sudden surges on the fuel supply.

The forms of invention so far described are designed for the carburetion of a single fuel. By changing the construction of the float chamber and fuel well to provide a modified multiple float chamber and fuel control arrangement as illustrated in Figures 6 and 7, our invention may be arranged to supply a volatile fuel mixture for starting, idling and acceleration purposes, and for operation below the speeds and compressions where lower grade fuels such as distillates, alcohol and the like may be effectively consumed in the engine, and at engine compressions and speeds sufficient to effectively burn a heavier fuel supplying a suitable heavier lower cost fuel. The nature of the fuel mixture supplied to the engine is determined automatically by our improved device in accordance with the engine compression and speeds.

In Figures 6 and 7, parts similar to those heretofore illustrated and described in detail in connection with Figures 1 to 4, inclusive have been given like reference characters and the description thereof will not be repeated as reference may be had to the foregoing description for a full understanding thereof. In this form of invention, the casting 2 is divided by dividing wall 191 and central tubular section 15 which extend to the top of the bowl casting into the gasoline chamber 13 and a heavy fuel or distillate chamber 192. Gasoline controlling float 12 is semi-annular in form, and bi-metallic thermostatic strip 35 which operates the conical valve 34 is fastened to boss 37 on the bottom of chamber 13. A distillate float 193 similar in construction to the gasoline float 12 is supported from pin 11 by the bracket 10 which operates a needle valve 9 of a float valve assembly 8 similar to the gasoline float assembly heretofore described to maintain a predetermined level of distillate in chamber 192, as will be obvious to those skilled in the art. The float pivots and chambers are so disposed that with the carburetor in position on a vehicle engine fuel surges caused by sudden vehicle stops close valve 9 and such surges have no effect on the float chamber fuel level or on the fuel supply to the jet in operation, a novel feature of our invention.

Gasoline chamber 3 is connected by gasoline by-pass passage 31 which is controlled by valve 34, to annular chamber 28 at the base of the tubular fuel member 29, from which gasoline passes through openings 194 into well chamber 41, so long as the carburetor is cold and until valve 34 has been closed by the action of the thermostatic strip 35 in the manner hereinbefore set forth in detail. Metering stem 52′ is provided with bore 195 in its lower end in which spring 196 is nested, the lower end of which abuts against head 197 of a fuel controlling valve stem 198 which extends slidably through a central bore formed in metering valve member 52. These parts are held in assembled relation by the metering member 52, which is provided with a threaded shank screwed into the tapped lower end of bore 195. Fuel valve operating rod 198 extends centrally downward through well member 29 and gasoline chamber 19 which chamber communicates with the gasoline float chamber 13 through passage 16 in a manner hereinbefore set forth. The lower end of stem 198 engages the central portion of perforated web 199 of cylindrical fuel control valve 200. Fuel control valve 200 is slidably mounted in a cylindrical bore formed in the threaded shank of screw plug 201 and is urged upward so that it engages the lower end of rod 198 by a helical compression spring 202, disposed within the lower cylindrical section of valve 200 and nested in the bore of plug member 201. Plug member 201 is screwed into the lower tapped end of tubular extension 24 of main casting 1 below well member 29 and clamps the bowl casting 2 in position. A drain opening 203 is provided in the bottom of plug 201 which is closed by drain plug 205 and by the removal of which the float chambers 13 and 192 may be drained.

Cylindrical valve 200 in its lowermost position is arranged to cover annular chamber 206 which communicates through openings 207 with annular chamber 208 formed at the base of tubular extension 24 of main casting 1. Chamber 208 is connected by means of distillate inlet passage 209, (Figure 7) to distillate chamber 192. In its lowermost position valve 200 therefore cuts off the flow of distillate from chamber 192 to well 41, and in its uppermost position, the upper edge of valve 200 is adapted to nest in cylindrical recess 19 formed in the bottom of well member 29 to cut off communication between the gasoline chamber 19 formed at the base of well member 29 and the interior of well 41. In the intermediate positions of the control tube and metering member 52, varying proportions of distillate and fuel will be permitted to pass from chambers 13 and 192 through chambers 19 and 208 into well 41 providing a fuel mixture, dependent upon the position of lower section 76 of the control tube assembly.

The remaining parts of the dual fuel carburetor illustrated in Figures 6 and 7 including the fuel nozzle divided control tube, starting arrangement and other essential parts, not shown, and the operation thereof are the same as illustrated and described in connection with Figures 1 to 5 inclusive.

Spring 195 acting on head 197 is stronger than the spring 202 acting on two way-valve 200 and consequently by proper arrangement and proportion of parts two way valve 200 can be held against the lower seat for any period of movement of metering pin 52 and the lower control tube section 76. If desired, metering pin 52 can be permitted to move upward one fourth or more of its total movement corresponding to one quarter opening or more of the carburetor and during this movement two way valve 200 may be held against its lower seat permitting only gasoline to flow. After such movement, a further comparatively slight opening movement of the lower throttle section disposes valve 200 between both valve seats permitting fuel to enter well 41 from both float chambers, and a further slight opening movement of the lower throttle section closes the valve against the top seat and leaves the lower valve opening fully open, cutting off the gasoline supply and permitting only heavier fuel from chamber 192 to pass to well 41 and the fuel nozzle.

Under wide open throttle conditions, the lower control tube section together with stem 52′ and metering member 52 are velocity controlled only since the lower tube section 76 is not mechanically fast to upper section, but merely rides the air stream with spring 88 opposing the air stream, so that under and at low speeds with wide open throttle, the lower control tube section 76 is depressed by spring 88 and where the speeds are sufficiently low, will operate two way valve 200 with no movement of the accelerator controlled throttle tube section 78. Such conditions exist during acceleration, on hills and at any low speed under wide open accelerator and throttle conditions. Therefore, in operation, valve 200 may be mechanically forced down by the action of closing the throttle, but it cannot be mechanically forced open by any other means than velocity of ingoing air.

Accordingly, with our carburetor installed on a vehicle engine operating at idling speed, the control tube assembly is forced downward by the controlling accelerator and metering pin 52 is forced to its lowermost position restricting fuel mixture flow to the nozzle to a minimum, while valve 200 is held down against its lower seat, and all flow of distillate from chamber 192 is therefore cut off, while gasoline flows freely to the well past the open upper seat of valve 200. The engine is therefore idling on gasoline or volatile fuel only from chamber 13.

As the throttle is opened, the control tube assembly and metering member 52 move up slightly as the engine speed picks up but the spring arrangement acting on valve 200 is such that it remains against its lower seat. The engine will gain in speed with the throttle opening but the proportioning of parts is such that it will be supplied entirely with gasoline until the engine speed and compression has been built up to a point where a heavier grade of fuel can be effectively utilized by the engine. After this point is reached as the throttle opens still further, two way valve 200 moves upward with throttle and distillate from chamber 192 will be admitted to well 41 while the relative quantity of gasoline or volatile fuel admitted thereto from chamber 13 will be decreased. Small movements either way change the fuel ratio accordingly fed to well 41 from chambers 13 and 192, an important feature of our invention. When the use of distillate is started a small quantity only is used, and a gradually blended change-over from one fuel to the other is secured, so that at the higher speeds and compressions where the engine can operate effectively on distillate or the heavier fuel, only the heavier fuel will be supplied. As the throttle is either gradually or quickly closed the order of operation of valve 200 above given is reversed and a correct fuel mixture to meet the engine requirements at different speeds and compression ratios is supplied.

Also with wide open throttle and low engine speed, the position of the lower control tube section 76 is controlled by the velocity of the ingoing air and spring 88 with no motion of the accelerator itself, and the fuel mixture is properly proportioned for engine operating conditions automatically in accordance with engine speeds and compression which determine the velocity of the ingoing air through the control tube assembly. Therefore, when during acceleration or hill work the speed falls below a predetermined value, spring operating lower control tube section 76 partially closes the throttle opening at the nozzle, and the mixture of fuel is changed from straight distillate or heavier fuel to a suitable ratio of heavy fuel and gasoline, and under severe conditions cuts off the heavy fuel entirely, and only gasoline is supplied to the engine until the speed picks up. The operation is therefore entirely automatic and correct fuel mixtures for the engine requirements are supplied with no need for manual control.

If it is desired to utilize heavier fuels than can be efficiently burned in the engine, or to assure that such heavier fuels will be burned effectively in view of the wide variation of such commercial fuels, valve 200 may be constructed so that in its fully closed position it will permit a sufficient supply of gasoline to flow to well 41 to supply a proper operating mixture of the lowest grade fuel that may in practice be fed to chamber 193.

Having described preferred embodiments of our invention, only, it will be apparent to those skilled in the art that our invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiments are therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

What we claim and desire to secure by United States Letters Patent is:—

1. In a carburetor for an internal combustion engine, a fuel supply chamber provided with inlet and outlet openings; tandem metering pins controlling said inlet and outlet openings respectively; means for admitting a variable air supply to said chamber between said metering pins to vary the richness of the engine idling fuel mixture supply; and means for establishing atmospheric pressure between said tandem metering pins whenever the pressure on engine side of carburetor goes below engine idling pressures.

2. A carburetor comprising a mixing chamber in the form of a venturi, having a movable throat section, a fuel nozzle coaxially alined with said venturi and forming together with said throat section a throttle, one end of said venturi having an outlet adapted to be subjected to the intake vacuum of an internal combustion engine and an air inlet open to the atmosphere whereby said throat section is subjected to a draft of air tending to move it away from said nozzle, means operable to prevent said throat section from moving away from said nozzle, and resilient means between said first mentioned operable means and said throat section whereby when said operable means is operated the force exerted on said throat section by said resilient means is reduced.

3. In a carburetor, a casing, a Venturi tube comprising a plurality of sections including a throat section, said sections being adapted to move within cylindrical portions of said casing, a fuel nozzle for delivering hydrocarbon fuel in front of the throat of said venturi, and cooperating with said throat to reduce the area of said venturi, means for connecting one end of said venturi in communication with the intake manifold of an internal combustion engine, means for connecting the opposite end of said venturi to the atmosphere, manually operable means to move one of said sections, resilient means between said manually operable section and said throat section normally urging said sections apart and automatic means responsive to the vacuum in said intake manifold to move said throat section away from said nozzle and against the action of said resilient means.

4. In a carburetor, a Venturi tube having a movable mouth and throat section, one end of said tube being adapted to be connected to the in-

take manifold of an internal combustion engine and the other end being open to the atmosphere whereby an air stream is created through said venturi, a fuel nozzle adapted to cooperate with said throat section to regulate the richness and amount of fuel mixture delivered to said manifold, operable means to move said mouth section and means to cause said throat section to move toward said mouth section in response to the load and speed of said engine.

5. The combination as set forth in claim 4, in which said fuel nozzle has an annular recess adapted to deliver a thin sheet of fuel at right angles to said air stream.

6. The combination as set forth in claim 4, and means responsive to the vacuum in said intake manifold to control said throat section whereby a minimum velocity is maintained in said air stream.

7. The combination as set forth in claim 4, wherein said nozzle has a fuel valve arranged centrally of said nozzle.

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