May 14, 1935. W. S. SMITH 2,001,670

INTAKE SYSTEM FOR MULTICYLINDER INTERNAL COMBUSTION ENGINES

Filed July 7, 1933 3 Sheets-Sheet 1

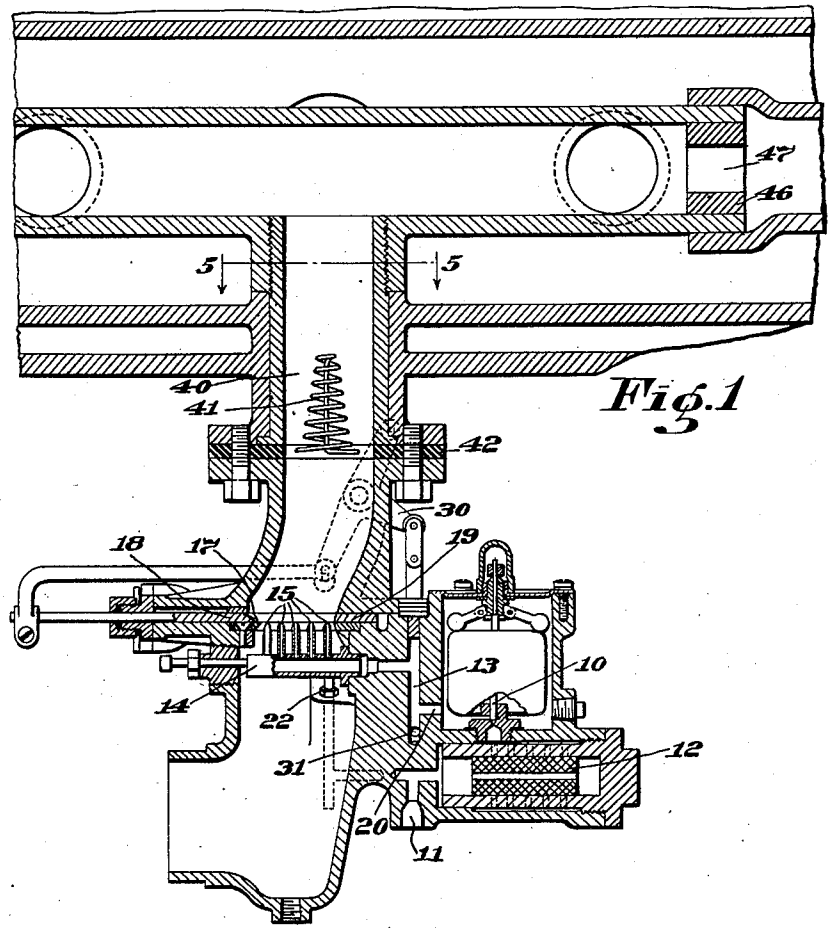


Fig. 1

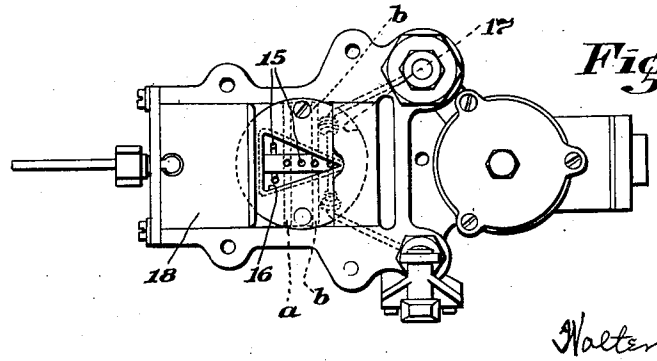


Fig. 2

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Fig. 3

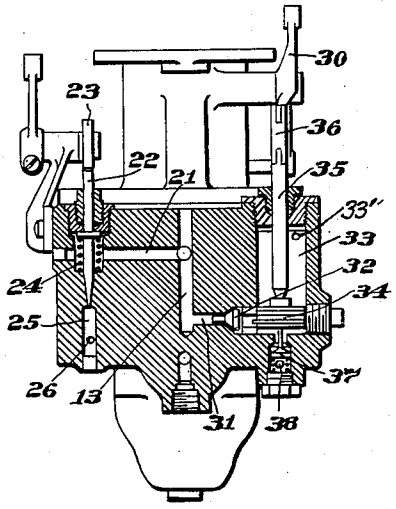


Fig. 4

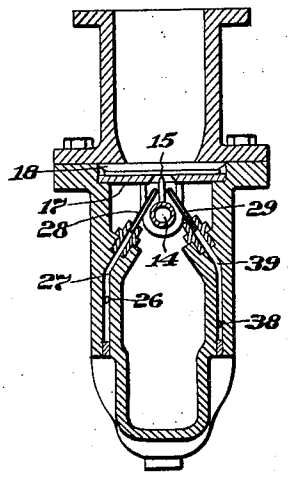


Fig. 5

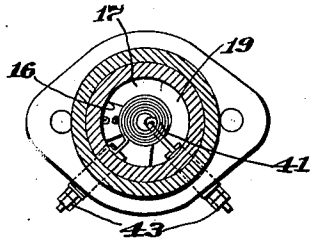
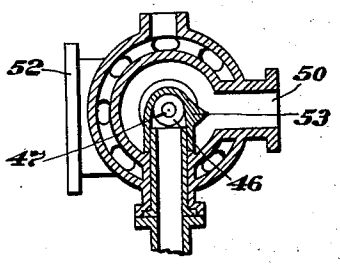


Fig. 8



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INTAKE SYSTEM FOR MULTICYLINDER INTERNAL COMBUSTION ENGINES

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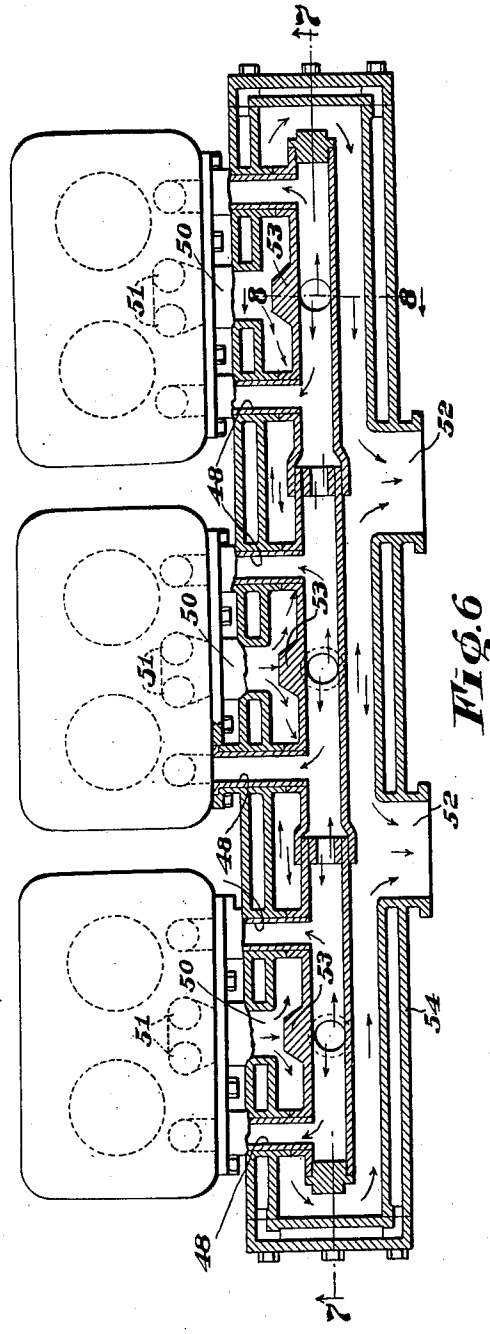


Fig. 6

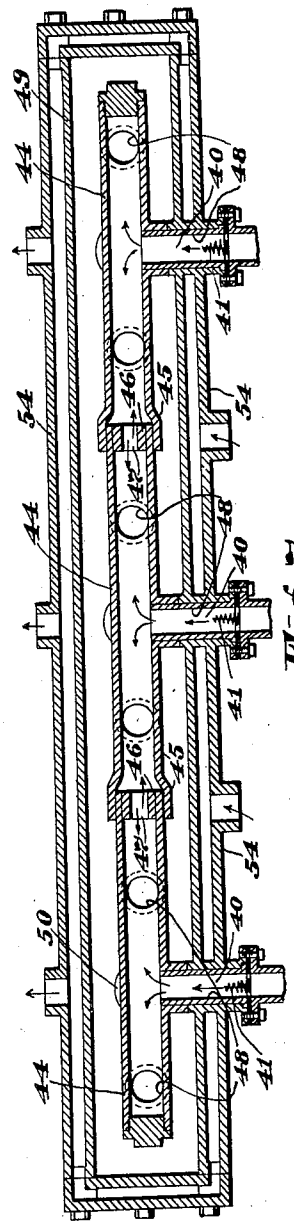


Fig. 7

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Patented May 14, 1935 2,001,670

UNITED STATES PATENT OFFICE

2,001,670

INTAKE SYSTEM FOR MULTICYLINDER INTERNAL COMBUSTION ENGINES

Walter S. Smith, Quincy, Mass., assignor to Shore Corporation, Dover, Del., a corporation of Delaware

Application July 7, 1933, Serial No. 679,411

48 Claims. (Cl. 123—122)

This invention relates to an intake system for multi-cylinder internal combustion engines, the present application being a continuation in part of my copending application Serial No. 601,647, filed March 28th, 1932. Reference is also made to my copending applications Serial No. 601,648 and Serial No. 601,649, filed of even date herewith, in which specific elements of the combination are disclosed and claimed.

The object of the invention is to provide such an intake system which will deliver to the cylinders of such an engine a proper fuel mixture, of which the fuel element may be hydrocarbon fuels heavier than gasoline, including the hydrogenated hydrocarbon, known as "safety fuel".

The intake system embodying my invention enables the engine to start on such fuels without the use of gasoline, an object long sought in this art, and to run well at all engine speeds and loads, particularly at low and idle speeds, with improved distribution and economy and to accelerate smoothly. At the same time the intake system provides a charge which is sufficiently cool to obtain good volumetric efficiency.

In order to accomplish these objects, I provide a carburetor with a number of nozzles or combinations thereof which are opened successively by the movement of the throttle valve which also controls the air supply and therefore the mixture. I thus effectively atomize and comminute the liquid fuel into small particles, which condition promotes its vaporization. I provide an intake passage from the carburetor throttle to the header of the intake manifold which passage is substantially axially in line with the outlet of the idling carburetor nozzle and is unobstructed except for an electric element which is heated during the starting period. By eliminating all throttling of this passage I maintain under part throttle conditions, including the starting period, a high degree of vacuum in the entire intake system from the carburetor nozzles to the intake valves. Such vacuum in itself promotes vaporization of the liquid fuel and it also induces high velocity of the liquid drawn from the active carburetor nozzle or nozzles thereby causing comminution of the liquid particles which also promotes vaporization.

The manifold of my intake system is divided into sections, each section preferably supplying two cylinders of the engine and each section served by the described carburetor and intake passage. The manifold sections are separated from one another by baffles or partitions in which there are restricted openings whereby the depression is maintained throughout the manifold without material variation.

By these means the mixture in a six-cylinder engine, for example, may be divided into three parts, approximately one third part in each manifold-carburetor unit, and because of the division at the carburetors the surface of the fuel in the liquid state is increased in relation to its volume whereby its vaporization is greatly promoted.

The intake manifold is surrounded by an exhaust jacket at or adjacent the connection of the carburetor to the manifold. The walls of the manifold and the carburetor connection are thereby heated so that they are able very effectively to heat and assist in the vaporization of liquid fuel brought in contact with them.

The liquid fuel, which may be deposited on the walls of a manifold section and particularly on the bottom thereof, where most of such liquid collects, is largely, if not wholly, prevented from passing to any other manifold section by the obstructions or restrictions between such sections. The distribution of this liquid is therefore largely, if not wholly, confined to the cylinders which draw from the manifold section in which this liquid is present and distribution errors are thereby greatly reduced. The fuel vapors, on the other hand, flow freely through the holes in the partitions and mingle with the air and other fuel vapors to form a mixture of the desired fuel-air ratio.

There are therefore combined in the intake system embodying my invention the following characteristics which effectively promote the vaporization of the liquid fuel, diminish distribution errors and increase economy, namely,—the comminution of the liquid fuel by the carburetor nozzle or nozzles, the maintenance at partly open throttle conditions of an increased vacuum at these nozzles and in the intake passages and manifold sections, heated wall surfaces of the intake passages near the manifold sections and in the manifold sections with which walls liquid may be brought in contact and deposited, a high surface to volume ratio of the liquid in the system, and the substantial restriction to each manifold section of the wall liquid contained in it.

In the drawings which illustrate an embodiment of my invention applied to a six-cylinder updraft internal combustion engine:—

Fig. 1 is a vertical longitudinal cross-section partly in elevation showing the principal por-

tions of a manifold unit, the carburetor and the electric resistance element;

Fig. 2 is a top plan view of the carburetor with the upper or flanged attaching portion removed therefrom better to show its construction;

Figs. 3 and 4 are cross-sections showing in detail certain features of the carburetor;

Fig. 5 is a cross-section taken on line 5, 5 of Fig. 1 showing in plan the electric resistance element;

Fig. 6 is a cross-sectional view showing the intake manifold and the exhaust jacket applied to a six-cylinder engine;

Fig. 7 is a vertical cross-section taken on the line 7—7 of Fig. 6 showing the three manifold sections and the passages or carburetor connections leading to them;

Fig. 8 is a vertical cross-section taken on the line 8—8 of Fig. 6.

Referring to Fig. 1, the carburetor includes a constant level mechanism of the usual type having a float controlled needle valve 10 which controls the admission of the liquid fuel through the channel 11 and the strainer 12 to the float chamber. The liquid fuel is led from the float chamber through a passage 13 to the interior of a removable and adjustable nozzle block 14 which holds a group of nozzles 15, of which in this embodiment of my invention there are six, as shown in Fig. 2. The nozzles 15 are arranged and held with their discharge outlets distributed in a triangular opening 16 of a plate 17 (Fig. 2). The discharge ends of the nozzles terminate in the plane of the surface of the plate 17. The opening 16 is beveled inward in the direction of the air flow so as to produce the effect of a Venturi air passage, the cross-section of which diminishes as the inner surface of said plate is approached.

A movable throttle valve 18 is arranged to contact, and, when actuated, to slide upon the plate 17 so as to vary the effective size of the opening 16 therethrough and positively and mechanically to shut off successively the nozzles 15 as the throttle is moved to the right in Fig. 1. The throttle valve 18 thus controls both the air flow through the opening 16 and the discharge of liquid fuel through the nozzles 15. The size of the openings in the nozzles is proportioned to provide the correct fuel air ratio for the desired operating characteristics.

When the throttle valve is in its fully closed position *b*, Fig. 2, it leaves a small restricted opening around but a single main nozzle 15 which remains open and two auxiliary nozzles as hereinafter described. The forward edge of the throttle valve 18 is beveled outwardly in the direction of the air flow to reduce the air flow resistance and to provide, together with the filler member 19, a passage of a Venturi-like shape.

When the throttle valve 18 is drawn to the left to the position *a* of Fig. 2 it uncovers three of the nozzles and at the same time enlarges the air opening in the plate 17. When the throttle plate is fully withdrawn to the left it opens all of the nozzles and the entire opening 16.

As shown in Fig. 1, the intake passage immediately beyond the nozzles is bent to the right and then extends vertically upwards thereby bringing the axis of its vertical portion in line with the idling or right-hand nozzle.

For starting the engine when cold, I provide means for supplying a greater amount of liquid fuel in proportion to the air than is necessary when the engine is running in normal operation. Liquid fuel flows from the carburetor float chamber through the passage 20 into the passage 13 and thence through passage 21 to a valve 22 held on its seat by a cam 23. When the cam 23 is withdrawn by the operator through suitable linkage leading to any convenient point, the valve 22 is lifted by the spring 24 and permits the liquid fuel to flow through the passages 25 and 26, Fig. 3, and 27, Fig. 4, to the nozzle 28 which delivers the liquid fuel at a point adjacent to the idling nozzle 15. These means feed the necessary excess fuel directly to the air stream and eliminate the necessity for the usual air choke.

I provide for an additional supply of liquid fuel during acceleration through the nozzle 29. This supply of liquid fuel may be automatically controlled by means of a mechanical linkage to the throttle control lever 30. The acceleration nozzle 29 is supplied with liquid fuel through the passages 20 and 31 which may be closed by a one-way valve 32 leading to the bottom of the cylindrical chamber 33. This chamber is vented as by the hole 33'. In this chamber are the movable piston 34 and rod 35 which are linked by part 36 to an arm on the lever 30. As the throttle is closed, the piston is actuated so as to draw in through the valve 32 a quantity of liquid fuel which is maintained in the chamber below said piston by means of the spring pressed valve 37. When the throttle is opened for acceleration, the piston 34 is thrust downwardly so as to close the valve 32 and open the valve 37 and force the liquid through the channels 38 and 39 to the acceleration nozzle 29. This nozzle 29 is shown as located adjacent to the idling nozzle, but it may be located in any desired position in the opening 16 in the plate 17.

To provide means for heating the liquid fuel during the starting period, I place in the passage 40 an electric element 41 having its ends leading through an insulating medium 42 to terminals 43 on the exterior of the pipe, Fig. 5.

The intake manifold-carburetor units are shown in Figs. 6, 7 and 8. Each passage 40 leads to a manifold header section 44. The header sections are connected together at 45 with telescopic joints to allow for expansion and contraction. Between adjacent header sections is an annular baffle or partition 46 having a central hole 47 therein. Each header section supplies fuel to two of the six cylinders through oulets 48.

The intake manifold as a whole is surrounded by a jacket 49 into which the hot exhaust gases are led through passages 50 from the exhaust valves 51. The exhaust gases escape from the jacket through the outlets 52 to the usual exhaust pipe.

Each of the intake manifold sections is provided with a projection 53 which deflects the exhaust gases. The size of these deflectors is determined by the degree to which it is desirable or necessary to heat the intake manifold sections. To increase the heat transfer the size of the deflectors may be reduced, or they may be omitted altogether so that the exhaust gases may impinge directly upon the outside of the intake header 44.

As shown in this embodiment of my invention the exhaust jacket 49 is surrounded by a water jacket 54 to cool the exhaust jacket, as ordinarily preferred for marine purposes or other service where hot exhaust is not desired, though, of course, this has no relation to the functioning of the intake system.

The mode of operation of the above described embodiment of my invention is as follows:—

Assume that the engine is cold and is to be started. The engine is "turned over" by a starting mechanism. The operator manipulates the mechanism connected to the cam 23 to release the valve 22 and permit an additional supply of liquid to flow to the auxiliary nozzle 28. He pushes the throttle plate 18 to the right as far as possible into position *b*, Fig. 2, thereby leaving only a very small air opening surrounding the idling nozzle 15 and the starting nozzle 28. Owing to the small air orifice around these nozzles and to its Venturi-like shape, the suction of the cylinders creates a high vacuum in the manifold units consisting of the intake passages and header sections. This high vacuum imparts to the air drawn through the restricted opening around the starting nozzles and to the liquid issuing from those nozzles a high velocity which atomizes or comminutes the liquid fuel and projects the particles against the electric element 41 which is highly heated by the passage of an electric current therethrough. The use of the starting nozzle 28 provides enough additional liquid so that there are sufficient light ends of the fuel to be readily evaporated by the heat of the electric element 41 on which the comminuted liquid particles are thrown.

Maintenance of a high vacuum throughout all of the manifold units at starting and under other partly open throttle conditions is secured by the suctions through the holes in the baffle plates 46. This high vacuum greatly promotes vaporization. When there are three carburetors and three heating elements for the six-cylinder engine, the liquid fuel thrown against a single heating element 41 is about only one-third the amount of the fuel which would be thrown on such an element if the engine were equipped with only one carburetor, one intake passage and one heating element. By the use of the heating elements, carburetors and intake passages, the vaporization of the liquid fuel is thus greatly promoted.

As a result of these combined factors, the lighter ends at least of the liquid fuel are readily vaporized and their vapors, mixed with the proper proportion of air, are drawn into the cylinders where the mixture readily ignites and burns.

As soon as the engine fires, the hot exhaust gases flow through the exhaust jacket surrounding the intake manifold sections and parts of the intake passages and/or carburetor connection and heat their walls thereby heating and promoting the vaporization of any liquid fuel brought in contact with them.

After the engine has been started, the current through the heating element 41 is shut off and the valve 22 is closed to cut off the supply of fuel to nozzle 28. The throttle plate 18 may be moved to open more nozzles and increase the air supply according to the demands of load and, or speed.

The vacuum, which is maintained in all of the manifold units, draws the liquid fuel, which is comminuted by the several carburetor nozzles, through the intake passages and into the manifold sections. Any liquid that gets on the walls of the carburetor connection is blown along by the vapor stream and is heated by those walls whereby its vaporization is promoted.

The liquid which is brought in contact with the heated walls of the header is heated thereby and largely vaporized.

The amount of liquid in one manifold section is but a fraction of the entire amount of liquid supplied to the engine. Hence this liquid is relatively small in amount and is distributed in a manifold section and therefore affords a large surface to volume ratio, thereby promoting vaporization.

Any unvaporized liquid that may be on the walls of a manifold section would be confined therein and substantially prevented from escaping therefrom by the baffles 46 in which the holes 47 are central or well above the bottom of the manifold so that the wall liquid would not flow through these holes and into another manifold section than that to which it had been delivered. As distribution errors arise almost entirely from the delivery of liquid fuel to a cylinder for which it was not intended, the restriction of the liquid fuel to a single manifold section supplying only a fraction of the cylinders of a multi-cylinder engine effectively reduces the distribution errors as compared with a manifold which feeds all of the cylinders of such an engine.

As the mixture in the cylinder which receives the leanest mixture must be rich enough for effective combustion and power, it is often necessary to set the carburetor of a multi-cylinder engine so as to deliver a mixture which is unnecessarily rich for the other cylinders and hence a loss of economy results. By means of my invention distribution errors are reduced and the engine may be run on a comparatively lean mixture with resulting economy.

Inasmuch as my intake system provides for the effective comminution and vaporization of the liquid fuel as above described, its vaporization is practically complete. Inasmuch as vaporization is practically complete, the mixture itself is kept comparatively cool because vaporization is an endothermic phenomenon. Consequently the temperature of the mixture delivered by my intake system to the cylinders of the engine is low enough to secure good volumetric efficiency.

Having described my invention, what I claim is:—

1. In an intake system for an internal combustion engine, an intake pipe, carburetor nozzles including an idling nozzle in said intake pipe, a throttle adapted to open and close at least some of said nozzles successively and to vary correspondingly the air opening around said nozzles, the intake pipe being otherwise unthrottled, and a resistance element adapted to be heated electrically and located in said intake pipe beyond the throttle in the path of the liquid fuel as it is drawn from the idling nozzle, whereby in starting the engine the vacuum caused by cylinder suction may be maintained in the intake system to the idling nozzle and liquid fuel may be drawn from said nozzle at high velocity, thrown against said resistance element, heated and vaporized at reduced pressure.

2. In an intake system for an internal combustion engine, an intake pipe, carburetor nozzles including an idling nozzle in said intake pipe, a throttle adapted to open and close at least some of said nozzles successively and to vary correspondingly the air opening around said nozzles, the intake pipe being otherwise unthrottled and having a section in substantial axial alignment with the outlet of said idling nozzle, and a resistance element located centrally in said section and adapted to be electrically heated, whereby in starting the engine the vacuum caused by cylinder suction may be maintained throughout the intake system to the idling nozzle and liquid fuel may

be drawn from said nozzle at high velocity, thrown against said resistance element, heated and vaporized at reduced pressure.

3. In an intake system for an internal combustion engine, an intake pipe, carburetor nozzles including an idling nozzle in said intake pipe, a throttle adapted to open and close at least some of said nozzles successively and to vary correspondingly the air opening around said nozzles, the intake pipe being otherwise unthrottled, an auxiliary nozzle adjacent to the idling nozzle, means to control the supply of liquid fuel to said auxiliary nozzle, and a resistance element adapted to be heated electrically and located in said intake pipe beyond the throttle in the path of the liquid fuel as it is drawn from the idling and auxiliary nozzles, whereby in starting the engine the vacuum caused by cylinder suction may be maintained in the intake system to the said nozzles and liquid fuel may be drawn from said nozzles at high velocity, thrown against said resistance element, heated and vaporized at reduced pressure.

4. In an intake system for an internal combustion engine having an intake pipe, a heating jacket on said intake pipe, and a connection between the engine and said jacket, a carburetor having a plurality of nozzles including an idling nozzle in said intake pipe, a throttle in said intake pipe adapted to open and close at least some of said nozzles successively and to vary correspondingly the air opening around said nozzles, the intake pipe being otherwise unthrottled, and a resistance element in said intake pipe adapted to be electrically heated and located beyond the throttle in the path of the liquid fuel drawn from the idling nozzle, whereby in starting the engine the vacuum caused by cylinder suction may be maintained to said idling nozzle, some liquid fuel may be sprayed at high velocity in said vacuum onto said heated resistance element, and some liquid fuel may be delivered to a section of the intake pipe in which it is substantially confined, so that vaporization is promoted.

5. In an intake system for multi-cylinder internal combustion engines, means for carbureting air and a supply of liquid fuel, including an idling nozzle and a plurality of secondary nozzles, means to supply air and liquid fuel to said nozzles, a throttle and fuel control valve located to close said secondary nozzles, means to move said valve to open said secondary nozzles, a valveless conduit extending from said carbureting means providing substantially unobstructed delivery of the carbureted mixture of air and fuel having a cylindrical portion substantially concentric with said idling nozzle, means cooperating with said valve to provide a concentrated air stream with fuel distributed therein by said nozzles, and means associated with said conduit for heating said mixture thereby to vaporize liquid particles entrained in said mixture.

6. An intake system for internal combustion engines comprising, means for carbureting air and a supply of liquid fuel, including an idling nozzle and a secondary nozzle, means to supply air and liquid fuel to said nozzles, a throttle and fuel control valve located to close said secondary nozzle, means to move said valve to open said secondary nozzle, a valveless conduit extending from said carbureting means providing substantially unobstructed means for delivery of the carbureted mixture of air and fuel having a cylindrical portion substantially concentric with said idling nozzle, means cooperating with said valve to provide a restricted air stream with fuel distributed therein, said conduit having transversely at the upper end thereof an opposing heated surface, and means in said conduit for heating said mixture thereby to vaporize liquid globules entrained in said mixture.

7. An intake system for internal combustion engines comprising, means for carbureting air and a supply of liquid fuel, including an idling nozzle and a secondary nozzle, means to supply air and liquid fuel to said nozzle, a throttle and fuel control valve located to close said secondary nozzle, means to move said valve to open said secondary nozzle, a valveless conduit extending from said carbureting means providing substantially unobstructed delivery of the carbureted mixture of air and fuel having a cylindrical portion substantially concentric with said idling nozzle, means cooperating with said valve to provide a restricted air stream with fuel distributed therein, said conduit having transversely at the upper end thereof an opposing heated surface, and an electric resistance unit in said conduit for heating said mixture thereby to vaporize liquid globules entrained in said mixture.

8. An intake system for internal combustion engines, comprising means for carbureting air and a supply of liquid fuel, including a primary, idling nozzle and a plurality of secondary nozzles, means to supply air and liquid fuel to said nozzles, a throttle and fuel control valve located to close said secondary nozzles, means to move said valve to open said secondary nozzles in succession, a valveless conduit extending from said carbureting means providing substantially unobstructed delivery of the carbureted mixture of air and fuel having a cylindrical portion substantially concentric with said idling nozzle and parallel to said secondary nozzles, means cooperating with said valve to provide a restricted air stream with fuel distributed therein, and means in said conduit for heating said mixture thereby to vaporize liquid globules entrained in said mixture.

9. An intake system for internal combustion engines, comprising means for carbureting air and a supply of liquid fuel, including a primary, idling nozzle and a plurality of secondary nozzles, means to supply air and liquid fuel to said nozzles, a throttle and fuel control valve located to close said secondary nozzles, means to move said valve to open said secondary nozzles in succession, a valveless conduit extending from said carbureting means providing substantially unobstructed delivery of the carbureted mixture of air and fuel having a cylindrical portion substantially concentric with said idling nozzle and parallel to said secondary nozzles, means cooperating with said valve to provide a restricted air stream with fuel distributed therein, means in said conduit for heating said mixture thereby to vaporize liquid globules entrained in said mixture, and electrically heated means intermediate said first mentioned heating means and said nozzles for initially heating said mixture upon starting.

10. A fuel-oil carburetor having in combination, an idling fuel nozzle, a number of other fuel nozzles, an inlet for the passage of air, a separable plate across and partially closing said inlet in the plane of the nozzle outlets, said plate having an opening therein of a predetermined size and shape, a throttle and fuel control valve in sliding engagement with said plate, adapted to open and close said other nozzles and correspondingly control the flow of air past the said nozzles, and a conduit for the mixture of air and oil de-

livered by said nozzles, said conduit having adjacent the outlet thereof a cylindrical portion parallel to said nozzles, the axis of said cylindrical outlet portion being substantially in line with said idling nozzle.

11. In a carburetor, a constant level fuel-supply-device, a conduit for the passage of air, a separable plate across and partially closing said conduit, said plate having an opening therein of a predetermined size and shape, a series of fuel jets of a predetermined discharge capacity disposed in said opening, including an idling jet and other jets fed from said device, a movable throttle adapted to slide across and control in a concentrated stream the flow of air through said predetermined opening and having the plane of the lower surface of said throttle closely adjacent the plane of the tops of said other jets to cover and uncover the said other jets in its opposite movements and correspondingly with the increase or decrease of the effective opening for said air flow, and a passage above said throttle for said fuel and air mixture, said passage having on the idling jet side of the same, adjacent said idling jet and opposite said throttle a wall of Venturi-like form, and said conduit being free of obstruction beyond any operating jet.

12. In a carburetor, a constant level fuel-supply-device, a conduit for the passage of air, a separable plate across and partially closing said conduit, said plate having an opening therein of a predetermined size and shape, a series of fuel jets, of a predetermined discharge capacity disposed in said opening, including an idling jet and other jets fed from said device, a movable throttle adapted to slide across and control the flow of air through said predetermined opening and having the plane of the lower surface of said throttle closely adjacent the plane of the tops of said other jets to cover and uncover the said other jets in its opposite movements and correspondingly with the increase or decrease of the effective opening for said air flow, and a passage above said throttle for said fuel and air mixture, said passage having a cylindrical outlet portion axially aligned with said idling jet and also having on the idling jet side of the same, adjacent said idling jet and opposite said throttle a wall of Venturi-like form.

13. A carburetor having in combination, an idling oil nozzle, a number of other oil nozzles, a valve adapted to open and close said other nozzles, means to move said valve to open and close said other nozzles, a plate defining the air opening around said idling nozzle and said other nozzles, the inner edge of the plate being beveled inward from bottom to top adjacent said idling nozzle and adapted to form with the valve a contracted concentrated air passage surrounding said nozzle, a conduit for the mixture of air and oil delivered by said nozzles having its opening adjacent the nozzles symmetrical to said nozzles as a group and having a cylindrical portion parallel to but spaced from said nozzles, the axis of said cylindrical portion being substantially in line with said idling nozzle but axially offset from said air opening.

14. A carburetor having in combination, an idling oil nozzle, a number of other oil nozzles, a valve adapted to open and close said other nozzles, means to move said valve to open and close said other nozzles, a plate defining the air opening around said idling nozzle and said other nozzles, the inner edge of the plate being beveled inward from bottom to top adjacent said idling nozzle and adapted to form with the valve a contracted concentrated air passage surrounding said nozzle, a conduit for the mixture of air and oil delivered by said nozzles having its opening adjacent the nozzles symmetrical to said nozzles as a whole and having a cylindrical portion parallel to but spaced from said nozzles, the axis of said cylindrical portion being substantially in line with said idling nozzle.

15. A carburetor having in combination a number of oil nozzles, a sliding valve member adapted to close said nozzles, means to move said member to uncover at least some of said nozzles in succession, a plate defining at least in part the air opening around said nozzles, the inner edge of the plate being beveled inward from bottom to top and that part of the plate near the nozzle to be first uncovered forming a contracted air passage adjacent said nozzle, a passage for the mixture of air and oil delivered by said nozzles having its opening adjacent the nozzles symmetrical to said nozzles as a whole and having walls curved above said opening in the direction of said first nozzle to be opened and then becoming cylindrical, to define cylindrical portions, parallel to said nozzles, the axis of said cylindrical portions being substantially in line with said first nozzle to be opened.

16. A carburetor having in combination a number of oil nozzles, a sliding valve member adapted to close said nozzles, means to move said member to uncover at least some of said nozzles in succession, a plate defining at least in part the air opening around said nozzles, the inner edge of the plate being beveled inward from bottom to top and that part of the plate near the nozzle to be first uncovered forming a contracted air passage adjacent said nozzle, an unobstructed passage above said nozzles for the mixture of air and oil delivered by said nozzles having its opening adjacent the nozzles symmetrical to said nozzles as a whole and having walls curving above said opening in the direction of said first nozzle to be opened and then becoming cylindrical, to define cylindrical portions, parallel to said nozzles, the axis of said cylindrical portions being substantially in line with said first nozzle to be opened.

17. A fuel oil carbureter having in combination, an idling fuel nozzle, a number of other fuel nozzles, a combined throttle and fuel control valve adapted to open and close said nozzles, a plate defining a triangular shaped air opening around the nozzles, the apex of the triangle being located adjacent the idling fuel nozzle, means to move said valve across said air opening thereby to control the flow of air past the said nozzles, and a conduit for the mixture of air and oil delivered by said nozzles, said conduit having adjacent the outlet thereof a cylindrical portion parallel to the nozzles, the axis of said cylindrical outlet portion being substantially in line with said idling nozzle.

18. A fuel oil carbureter having in combination, an idling fuel nozzle, a number of other fuel nozzles, a combined throttle and main fuel control valve adapted to open and close said other nozzles, and correspondingly control the flow of air past said nozzles, means to supply liquid fuel to said nozzles, means to supply additional fuel to a point immediately adjacent said idling fuel nozzle and throttle, for passage with the air, past said throttle, means independent of any throttle and main fuel control to control flow of said additional fuel, and a conduit for the mixture of air and oil delivered by said nozzles, said conduit having adjacent the outlet thereof a cylindrical por-

tion parallel to said main nozzles, the axis of said cylindrical outlet portion being substantially in line with said idling nozzle.

19. A fuel oil carbureter having in combination, an idling fuel nozzle, a number of other fuel nozzles, a combined throttle and main fuel control valve adapted to open and close said other nozzles and correspondingly control the flow of air past said nozzles, means to supply liquid fuel to said nozzles, means to supply additional liquid fuel, including an auxiliary nozzle disposed to discharge immediately adjacent said idling fuel nozzle and throttle, for passage with the air, past said throttle, means independent of any throttle and main fuel control including a manually and independently operated valve to control flow of said additional fuel, and a conduit for the mixture of air and oil delivered by said nozzles, said conduit having adjacent the outlet thereof a cylindrical portion parallel to said main nozzles, the axis of said cylindrical outlet portion being substantially in line with flow of fuel from said idling nozzle and said auxiliary nozzle.

20. A fuel oil carbureter having in combination, an idling fuel nozzle, a number of other fuel nozzles, a combined throttle and main fuel control valve adapted to open and close said other nozzles and correspondingly control the flow of air past said nozzles, means to supply liquid fuel to said nozzles, an auxiliary fuel nozzle located on one side of said idling fuel nozzle to supply additional fuel to a point immediately adjacent said idling fuel nozzle and throttle, for passage with the air past said throttle, an accelerating device including a second auxiliary nozzle located on the opposite side of said idling nozzle from said first auxiliary nozzle for supplying additional fuel during acceleration to a point immediately adjacent said idling nozzle, means independent of any throttle and main fuel control to control flow of additional fuel through one of said auxiliary nozzles, and a conduit for the mixture of air and oil delivered by said nozzles, said conduit having adjacent the outlet thereof a cylindrical portion parallel to said nozzles, the axis of said cylindrical outlet portion being substantially in line with flow of fuel from said idling nozzle and auxiliary nozzles, and free of obstruction beyond any operating nozzle.

21. A fuel oil carbureter having in combination, an idling fuel nozzle, a number of other fuel nozzles, a combined throttle and main fuel control valve adapted to open and close said other nozzles and correspondingly control the flow of air past said nozzles, means to supply liquid fuel to said nozzles, an auxiliary fuel nozzle located on one side of said idling fuel nozzle to supply additional fuel to a point immediately adjacent said idling fuel nozzle and throttle, for passage with the air, past said throttle, an accelerating device including a second auxiliary nozzle located on the opposite side of said idling nozzle from said first auxiliary nozzle for supplying additional fuel during acceleration to a point immediately adjacent said idling nozzle, means independent of any throttle and main fuel control including a manually and independently operated valve, to control flow of additional fuel through one of said auxiliary nozzles and a conduit for the mixture of air and oil delivered by said nozzles, said conduit having adjacent the outlet thereof a cylindrical portion parallel to said nozzles, the axis of said cylindrical outlet portion being substantially in line with flow of fuel from said idling nozzle and auxiliary nozzles, and free of obstruction beyond any operating nozzles.

22. A carburetor for internal combustion engines having in combination a conduit for the passage of air, a separable plate across and partially closing said conduit, said plate having an opening therein of a predetermined size and shape, a plurality of liquid fuel nozzles of a predetermined discharge capacity disposed in said opening, and a throttle plate in sliding engagement with said first plate and movable across said opening to open and close at least some of said nozzles in succession, the conduit beyond the throttle plate being unthrottled, and the size and shape of the said opening and the capacity of said nozzles being predetermined so that the movement of said throttle plate varies the effective size of said opening in proportion to the throttle-controlled discharge capacity of the open nozzles to maintain the desired fuel-air ratio of the mixture delivered by the carburetor.

23. A carburetor for internal combustion engines having in combination a conduit for the passage of air, a separable plate across and partially closing said conduit, said plate having an opening therein of a predetermined size and shape, a plurality of liquid fuel nozzles of a predetermined discharge capacity disposed in said opening, including an idling nozzle, and a throttle plate in sliding engagement with said first plate and movable across said opening to open and close at least some of said nozzles in succession, the conduit beyond the throttle plate being unthrottled and having a portion in substantial axial alignment with said idling nozzle, and the size and shape of the said opening and the capacity of said nozzles being predetermined so that the movement of said throttle plate varies the effective size of said opening in proportion to the throttle-controlled discharge capacity of the open nozzles to maintain the desired fuel-air ratio of the mixture delivered by the carburetor.

24. A carburetor for internal combustion engines having in combination a conduit for the passage of air, a separable plate across and partially closing said conduit, said plate having an opening therein of a predetermined size and shape, a plurality of liquid fuel nozzles of a predetermined discharge capacity disposed in said opening, including an idling nozzle, an auxiliary nozzle, means to control the flow of fuel to said auxiliary nozzle, and a throttle plate in sliding engagement with said first plate and movable across said opening to open and close at least some of said nozzles in succession, the conduit beyond the throttle plate being unthrottled and the size and shape of the said opening and the capacity of said nozzles other than the auxiliary nozzle being predetermined so that the movement of said throttle plate varies the effective size of said opening in proportion to the throttle-controlled discharge capacity of the open nozzles other than the auxiliary nozzle to maintain the desired fuel-air ratio of the mixture delivered by the carburetor.

25. A charge forming device for internal combustion engines comprising, means for carbureting air and a supply of fuel oil, including an idling oil nozzle and a secondary oil nozzle, means to supply air and oil to said nozzles, a throttle and fuel control valve located to close said secondary nozzle, means to move said valve to open said secondary nozzle, a valveless conduit extending from said carbureting means providing unobstructed delivery of the carbureted mixture of

air and oil having a cylindrical portion substantially concentric with said idling nozzle, means cooperating with said valve to provide a concentrated air stream with fuel uniformly distributed therein, said conduit having transversely at the upper end thereof an opposing heated surface, and means in said conduit for heating said mixture thereby to vaporize any liquid globules entrained in said mixture.

26. A charge forming device for internal combustion engines comprising, means for carbureting air and a supply of fuel oil, including an idling oil nozzle and a secondary oil nozzle, means to supply air and oil to said nozzles, a throttle and fuel control valve located to close said secondary nozzle, means to move said valve to open said secondary nozzle, a valveless conduit extending from said carbureting means providing unobstructed delivery of the carbureted mixture of air and oil having a cylindrical portion substantially concentric with said idling nozzle, means cooperating with said valve to provide a concentrated air stream with fuel uniformly distributed therein, said conduit having transversely at the upper end thereof an opposing heated surface, and an electric resistance unit in said conduit for heating said mixture thereby to vaporize any liquid globules entrained in said mixture.

27. A charge forming device for internal combustion engines comprising, means for carbureting air and a supply of fuel oil, including an idling oil nozzle and a secondary oil nozzle, means to supply air and oil to said nozzles, a throttle and fuel control valve located to close said secondary nozzle, a separable plate extending through the plane of said nozzles and effective to provide a restricted air orifice surrounding said idling oil nozzle, a valveless conduit extending from said carbureting means providing unobstructed delivery of the carbureted mixture of air and oil and having its axis aligned with and directly above said restricted orifice, said conduit having transversely at the upper end thereof an opposing heated surface, means cooperating with said valve to provide a concentrated air stream with fuel uniformly distributed therein, and means in said conduit for heating said mixture thereby to vaporize any liquid globules entrained in said mixture.

28. A charge forming device for internal combustion engines comprising, means for carbureting air and a supply of fuel oil, including an idling oil nozzle and a secondary oil nozzle, means to supply air and oil to said nozzles, a throttle and fuel control valve located to close said secondary nozzle, a separable plate extending through the plane of said nozzles and effective to provide a restricted air orifice surrounding said idling oil nozzle, a valveless conduit extending from said carbureting means providing unobstructed delivery of the carbureted mixture of air and oil and having its axis aligned with and directly above said restricted orifice, said conduit having transversely at the upper end thereof an opposing heated surface, means cooperating with said valve to provide a concentrated air stream with fuel uniformly distributed therein, and an electric resistance unit in said conduit for heating said mixture thereby to vaporize any liquid globules entrained in said mixture.

29. A charge forming device for internal combustion engines, comprising means for carbureting air and a supply of fuel oil, including a primary, idling oil nozzle and a plurality of secondary oil nozzles, means to supply air and oil to said nozzles, a throttle and fuel control valve located to close said secondary nozzles, means to move said valve to open said secondary nozzles in succession, a valveless conduit extending from said carbureting means providing unobstructed delivery of the carbureted mixture of air and oil having a cylindrical portion substantially concentric with said idling nozzle and parallel to said secondary nozzles, means cooperating with said valve to provide a concentrated air stream with fuel uniformly distributed therein, and means in said conduit for heating said mixture thereby to vaporize any liquid globules entrained in said mixture.

30. A charge forming device for internal combustion engines, comprising means for carbureting air and a supply of fuel oil, including a primary, idling oil nozzle and a plurality of secondary oil nozzles, means to supply air and oil to said nozzles, a throttle and fuel control valve located to close said secondary nozzles, means to move said valve to open said secondary nozzles in succession, a valveless conduit extending from said carbureting means providing unobstructed delivery of the carbureted mixture of air and oil having a cylindrical portion substantially concentric with said idling nozzle and parallel to said secondary nozzles, means cooperating with said valve to provide a concentrated air stream with fuel uniformly distributed therein, means in said conduit for heating said mixture thereby to vaporize any liquid globules entrained in said mixture, and electrically heated means intermediate said first mentioned heating means and said nozzles for initially heating said mixture upon starting.

31. A charge forming device for internal combustion engines, comprising in combination a fuel oil carbureter having a primary idling oil nozzle, a number of other fuel nozzles, a combined throttle and fuel control valve adapted to open and close said nozzles, a plate defining a triangular shaped air opening around the nozzles, the apex of the triangle being located adjacent the idling fuel nozzle, means to move said valve across said air opening thereby to control the flow of air past the said nozzles, and a conduit for the mixture of air and oil delivered by said nozzles, said conduit having adjacent the outlet thereof a cylindrical portion parallel to the nozzles, the axis of said cylindrical outlet portion being substantially in line with said idling nozzle, and said conduit being free of obstruction beyond any operating jet.

32. A charge forming device for internal combustion engines, comprising in combination a fuel oil carbureter having a primary idling oil nozzle, a number of other fuel nozzles, a combined throttle and fuel control valve adapted to open and close said other nozzles, and correspondingly control the flow of air past said nozzles, separable means positioned to maintain a sliding contact with said valve and effective to provide a restricted air orifice surrounding said idling oil nozzle, means to supply liquid fuel to said nozzles, means to supply additional fuel to a point immediately adjacent said idling fuel nozzle, means independent of any throttle and main fuel control to control flow of said additional fuel, and a conduit for the mixture of air and oil delivered by said nozzles, said conduit having adjacent the outlet thereof a cylindrical portion parallel to said nozzles, the axis of said cylindrical outlet portion being substantially in line with said idling nozzle, and said conduit being free of obstruction beyond any operating jet.

33. A charge forming device for internal com-

bustion engines comprising, means for carbureting air and a supply of fuel oil, including an idling oil nozzle and a secondary oil nozzle, means to supply air and oil to said nozzles, a throttle and fuel control valve located to close said secondary nozzle, means to move said valve to open said secondary nozzle, a valveless conduit extending from said carbureting means providing unobstructed delivery of the carbureted mixture of air and oil having a cylindrical portion substantially concentric with said idling nozzle, means cooperating with said valve to provide a concentrated air stream with fuel uniformly distributed therein, and means associated with said conduit for heating said mixture thereby to vaporize liquid globules entrained in said mixture.

34. A charge forming device for internal combustion engines comprising, means for carbureting air and a supply of fuel oil, including an idling oil nozzle and a secondary oil nozzle, means to supply air and oil to said nozzles, a throttle and fuel control valve located to close said secondary nozzle, means to move said valve to open said secondary nozzle, and a valveless conduit extending from said carbureting means providing unobstructed delivery of the carbureted mixture of air and oil having a cylindrical portion substantially concentric with said idling nozzle, means cooperating with said valve to provde a concentrated air stream with fuel uniformly distributed therein, said conduit having transversely of the upper end thereof an opposing heated surface.

35. A charge forming device for internal combustion engines comprising, means for carbureting air and a supply of fuel oil, including an idling oil nozzle and a secondary oil nozzle, means to supply air and oil to said nozzles, throttle and fuel control, a valve located to close said secondary nozzle, and to provide a restricted air orifice surrounding said idling oil nozzle, a valveless conduit extending from said carbureting means providing unobstructed delivery of the carbureted mixture of air and oil and having its axis aligned with and directly above said restricted orifice, means cooperating with said valve to provide a concentrated air stream with fuel uniformly distributed therein, and means associated with said conduit for heating said mixture thereby to vaporize any liquid globules entrained in said mixture.

36. A charge forming device for internal combustion engines comprising, means for carbureting air and a supply of fuel oil, including an idling oil nozzle and a secondary oil nozzle, means to supply air and oil to said nozzles, a throttle and fuel control valve located to close said secondary nozzle, and to provide a restricted air orifice surrounding said idling oil nozzle, and a valveless conduit extending from said carbureting means providing unobstructed delivery of the carbureted mixture of air and oil and having its axis aligned with and directly above said restricted orifice, said conduit having transversely of the upper end thereof an opposing heated surface, and means cooperating with said valve to provide a concentrated air stream with fuel uniformly distributed therein.

37. A charge forming device for internal combustion engines comprising means to carburete a supply of liquid fuel and air, means to conduct the mixture thus formed to the engine in accordance with demand, means to accelerate the flow of fuel by constricting the stream and reducing pressure in the zone of restriction, means to heat said fuel as it passes from the point of carburetion to the engine thereby to completely vaporize same, and means to simultaneously enlarge said restricted zone to at least ten times its initial area and to simultaneously add additional fuel into said stream from additional sources, while keeping the major portion of the fuel relatively remote from the margin of the stream.

38. A charge forming device for internal combustion engines comprising in combination a carbureter having a plurality of jets, one of said jets beings operable upon low speeds and others of said jets being adapted for operation as the speed and load is increased, means to supply fuel oil to said jets, means to supply air adjacent said jets for mixture with the oil issuing from the jets, means to control flow of oil from said jets in accordance with said speed and load conditions, means including an exhaust heated T to conduct the mixture of carbureted fuel to the engine, said means being positioned to permit passage of the mixture to said T and to permit said T to receive the impact of the fuel particles issuing from said idling jet without earlier material contact of the fuel globules with said conducting means, and means to heat said mixture on starting the engine as it leaves the point of carburetion thereby to further vaporize the said globules.

39. A charge forming device for internal combustion engines comprising in combination a carbureter having a plurality of jets, one of said jets being operable upon low speeds and others of said jets being adapted for operation as the speed and load is increased, means to supply fuel oil to said jets, means to supply air to said jets for mixture with the oil issuing from the jets, means to control flow of oil from said jets in accordance with said speed and load condition, means to conduct the mixture of carbureted air and fuel to the engine, said means being shaped and spaced to permit passage of the mixture therethrough without material contact of the fuel globules therewith, means to supply initial heat to the mixture upon starting of the engine, and additional means to heat said mixture on its passage through said conducting means.

40. A charge forming device for internal combustion engines, comprising in combination a carbureter having a primary idling oil nozzle and a plurality of additional oil nozzles, one of said nozzles being operable upon low speeds and others of said nozzles being adapted for operation as the speed and load is increased, means to supply fuel oil to said nozzles, means to supply air to said nozzles for mixture with the oil issuing from the nozzles, means to control flow of oil from said nozzles in accordance with said speed and load conditions, comprising a valve positioned to close said additional nozzles and to open said nozzles in succession, means to conduct the mixture of carbureted air and fuel to the engine, said means being shaped and spaced to permit passage of the mixture therethrough without material contact of the fuel globules therewith, and means to heat said mixture as it leaves the point of carburetion thereby to further vaporize said globules.

41. The method of forming and delivering a charge of hydrocarbon fuels and air, which consists in sucking air in a moving confined stream, temporarily constricting said stream to increase its speed and to reduce the pressure in the zone of the restriction, sucking the fuel from a source in said restricted zone and intermediate the confines of said stream, carrying the fuel vertically upwardly in the moving stream issuing from said source meanwhile keeping the major portion

of said discharged fuel relatively remote from the margin of said stream, heating by direct contact and centrally of the stream, said major portion of the fuel, enlarging said restricted zone to at least ten times its initial area and meanwhile discharging additional fuel into the air stream thus enlarged from additional sources other than said first mentioned source and then heating the fuel by impact and direct contact with a heated surface transversely disposed with reference to said vertically moving stream.

42. The method of forming and delivering a charge of hydrocarbon fuels and air, which consists in sucking air in a stream, constricting said stream to increase its speed and to reduce the pressure in the zone of said restriction, sucking the fuel from a source in said restricted zone, carrying the fuel upwardly in the moving stream issuing from said source meanwhile keeping the major portion of said fuel relatively remote from the margin of said stream, enlarging the cross sectional area of said restricted zone at least ten times and meanwhile discharging additional fuel into the air stream thus enlarged from additional and adjacent sources other than said first mentioned source, said additional sources being substantially uniformly disposed throughout said enlarged cross sectional area.

43. A charge forming device for internal combustion engines, comprisng in combination a fuel oil carbureter having a primary idling oil nozzle, a number of other fuel nozzles, a combined throttle and fuel control valve adapted to open and close said other nozzles, separable means defining an air opening around said idling nozzle and said other nozzles, means to move said valve across said air opening thereby to control the flow of air past the said nozzles, said opening progressively increasing in size from a point adjacent the idling nozzle in accordance with positions of the valve, and a conduit for the mixture of air and oil delivered by said nozzles, said conduit having adjacent the outlet thereof, a cylindrical portion parallel to the nozzles, the axis of said cylindrical outlet portion being substantially in line with said idling nozzle, and said conduit being free of obstruction beyond any operating jet.

44. A charge forming device for internal combustion engines, comprising in combination a fuel oil carbureter having a primary idling oil nozzle, a number of other fuel nozzles, a combined throttle and fuel control valve adapted to open and close said other nozzles and correspondingly control the flow of air past said nozzles, means to supply liquid fuel to said nozzles, means to supply additional liquid fuel, including an auxiliary nozzle disposed to discharge immediately adjacent said idling fuel nozzle, means independent of any throttle and main fuel control including a manually and independently operated valve to control flow of said additional fuel, and a conduit for the mixture of air and oil delivered by said nozzles, said conduit having adjacent the outlet thereof a cylindrical portion parallel to said nozzles, the axis of said cylindrical outlet portion being substantially in line with flow of fuel from said idling nozzle and said auxiliary nozzle, and said conduit being free of obstruction beyond any operating jet.

45. A carbureter having in combination an idling fuel nozzle, a number of other fuel nozzles, a combined throttle and main fuel control valve adapted to open and close said other nozzles, and correspondingly control the flow of air past said nozzles, means to supply liquid fuel to said nozzles, an auxiliary fuel nozzle located on one side of said idling fuel nozzle to supply additional fuel to a point adjacent said idling fuel nozzle and throttle, for passage with the air past said throttle, an accelerating device including a second auxiliary nozzle located on the opposite side of said idling nozzle from said first auxiliary nozzle for supplying additional fuel during acceleration to a point adjacent said idling nozzle, means independent of any throttle and main fuel control, to control flow of additional fuel through one of said auxiliary nozzles, and a conduit for the mixture of air and fuel delivered by said nozzles, said conduit having adjacent the outlet thereof a cylindrical portion parallel to said nozzles, the axis of said cylindrical portion being substantially in line with flow of fuel from the nozzles.

46. A carbureter having in combination, an idling fuel nozzle, a number of other fuel nozzles, an inlet for the passage of air, a separable plate across and partially closing said inlet in the plane of the nozzle outlets, said plate having an opening therein of a predetermined size and shape, a throttle and fuel control valve in sliding engagement with said plate, adapted to open and close said other nozzles and correspondingly control the flow of air past the said nozzles, and a conduit for the mixture of air and fuel delivered by said nozzles, said conduit having adjacent the outlet thereof a cylindrical portion parallel to said nozzles, the axis of said cylindrical outlet portion being substantially in line with said idling nozzles, means to supply additional fuel during acceleration comprising a well, an auxiliary nozzle communicating therewith for supplying the additional fuel to a point adjacent said idling nozzle, and control means for said additional fuel supply means associated with said throttle and fuel control valve.

47. A charge forming device for internal combustion engines comprising in combination a carbureter having a primary idling fuel nozzle, a number of other fuel nozzles, a combined throttle and fuel control valve adapted to open and close said other nozzles, and correspondingly control flow of air, past said nozzles, separable means positioned to maintain a sliding contact with said valve and effective to provide a restricted air orifice surrounding said idling fuel nozzle, means to supply liquid fuel to said nozzles, means to supply additional fuel during acceleration comprising a well, an auxiliary nozzle communicating therewith for supplying the additional fuel to a point adjacent said idling nozzle, and control means for said additional fuel supply means associated with said throttle and fuel control valve, and a conduit for the mixture of air and fuel delivered by said nozzles, said conduit having adjacent the outlet thereof a cylindrical portion parallel to said nozzles, the axis of said cylindrical outlet portion being substantially in line with said idling nozzle.

48. A charge forming device for internal combustion engines comprising means for carbureting air and liquid fuel, including an idling nozzle and a secondary nozzle, means to supply air and liquid fuel to said nozzles, a throttle and fuel control valve located to close said secondary nozzle, means to move said valve to open said secondary nozzle, means to supply additional fuel during acceleration comprising a well, an auxiliary

nozzle communicating therewith for supplying the additional fuel to a point adjacent said idling nozzle, and control means for said additional fuel supply means associated with said throttle and fuel control valve, a valve-less conduit extending from said nozzles providing unobstructed delivery of the carbureted mixture of air and liquid fuel, said conduit having a cylindrical portion substantially concentric with said idling nozzle, means cooperating with said valve, to provide a concentrated air stream with fuel uniformly distributed therein, and means associated with said conduit for heating said mixture thereby to vaporize liquid globules entrained in said mixture.

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