

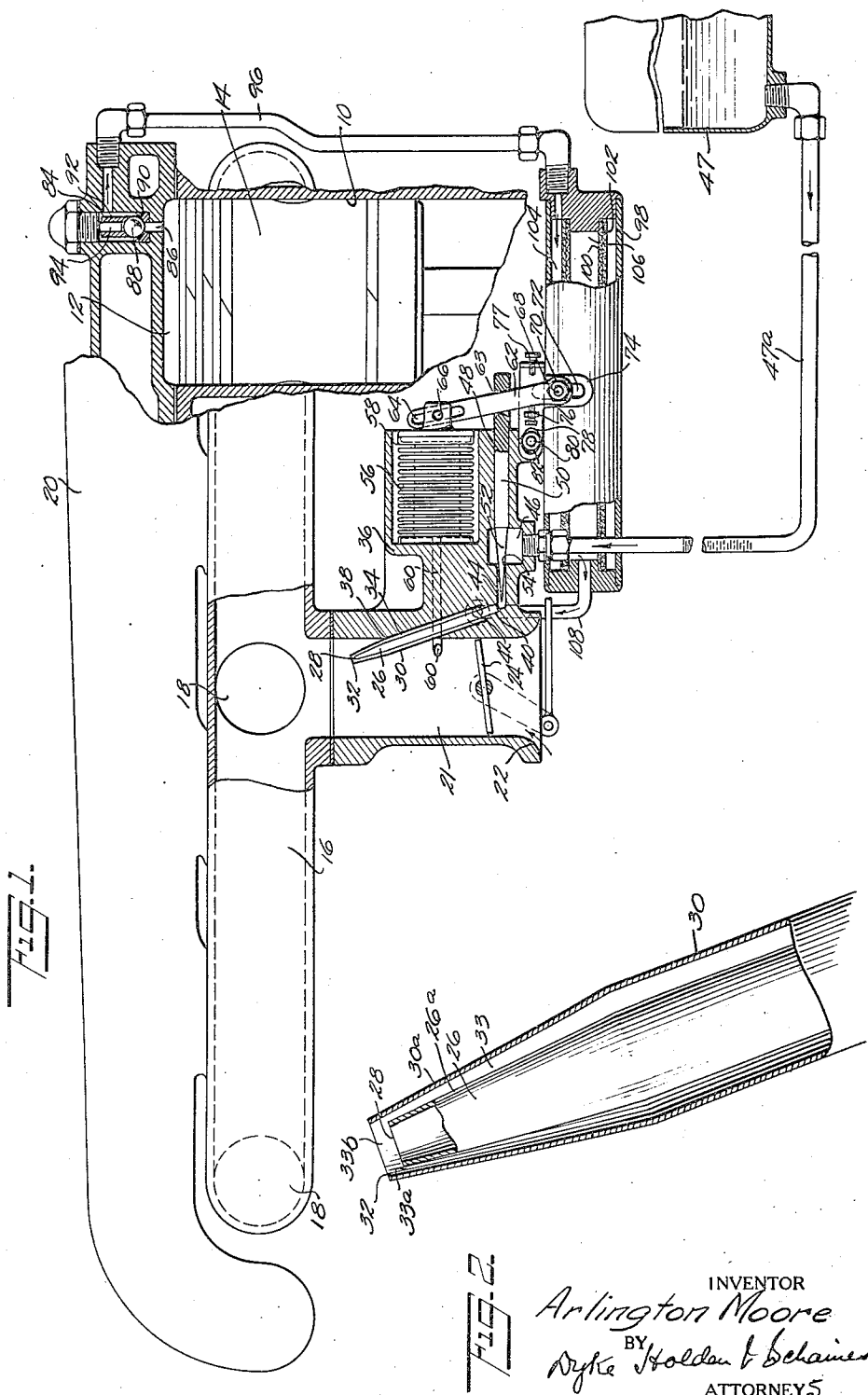
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SUPPLYING AND MIXING CHARGES FOR INTERNAL COMBUSTION ENGINES

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SUPPLYING AND MIXING CHARGES FOR INTERNAL COMBUSTION ENGINES

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My invention relates to improvements in supplying the components of the charge for internal combustion engines and mixing the same; and has for its object particularly to provide a novel method of charge supplying and mixing which produces full quantity delivery to the engine cylinders of a dense charge mixture in which the components are in thoroughly homogeneous admixture, with resulting improvement in completeness of combustion, power and economy.

Among the further objects of the invention are the following:

To provide a method in which the pressure about the fuel orifice for admitting the fuel into the air stream going to the engine cylinders is maintained sufficiently reduced throughout the operating range of the engine to effect the delivery of the fuel at such discharge orifice under atmospheric pressure directly from the main fuel supply tank, such as an automobile fuel supply tank, located in its usual position at a level which may be materially lower than the discharge orifice.

To provide a method in which the inversely varying forces developed by the engine are made to complement each other in producing a pressure drop at the fuel discharge orifice to permit of the delivery of fuel to the engine under a head of pressure which would be insufficient, except for said pressure drop, to effect fuel delivery.

To provide a method in which fuel under atmospheric pressure is elevated and discharged into the air stream between the throttle and engine cylinders by subjecting the discharge orifice thereof to the action of the general intake depression within the intake conduit and also to the action of a local pressure drop due to the passage of a portion of the cylinder gases at a high velocity in inductive relation to said discharge orifice.

To provide a method in which the heavier as well as the lighter constituents of heterogeneous fuels are introduced into the air stream going to the engine in a comminuted state so that the heavier constituents are utilized as effectively as the lighter ones, all of said constituents being retained in suspen-

sion in said air stream and in homogeneous mixture therewith, without dependence upon application of heat to the charge, or on use of high velocity passages.

To provide a method in which the variations in the differential between intake pressure and atmospheric pressure are utilized for controlling the extent of opening of the passage for certain of the components of the charge mixture, such as fuel delivered into admixture with the air component of said charge mixture, under the pressure drop due to intake depression and a supplementary pressure drop, whereby to vary the quantity of the first named component directly with the air supply in response to the variations in intake depression accompanying the variations of the air supply.

To provide a method in which the fuel throughout the operating range of the engine is first metered, and then mechanically disintegrated, and delivered into the air stream at a location between the air throttle and engine cylinders, so that the entire mass of air enroute to the cylinders after the same has been metered by the throttle becomes thoroughly permeated with the appropriate quantity of fuel.

To provide a method in which the cylinder gases together with the water vapor contained therein are delivered into the engine cylinders, in a cooled condition for improving combustion and volumetric efficiency.

To provide a novel apparatus capable of being employed in performing the steps of my said method.

Other objects will in part be obvious, and in part be pointed out hereinafter.

To the attainment of the aforesaid objects and ends, my invention consists in the novel features of construction, and in the method and steps thereof as hereinafter more fully described and then pointed out in the claims.

In the accompanying drawing:

Fig. 1 is an elevation partly in section showing one form of apparatus by which my novel method can be performed; and

Fig. 2 is an enlarged detail view of nozzles shown in Fig. 1.

Referring to the drawing, the engine com-

prises the cylinders 10, combustion chambers 12, and pistons 14 working in said cylinders. The charge-distributing or intake manifold 16 communicates through the ports 18, and through the usual inlet valves, with the combustion chamber 12. The exhaust gases escape past the usual exhaust valves and out through the exhaust manifold 20. The intake manifold is preferably formed with generously wide sweeping passages and has a mixing chamber formed therein or otherwise constructed to communicate freely therewith. In the construction shown, the mixing chamber 21 replaces the usual intake manifold riser, and has a relatively wide flaring air inlet mouth 22, the extent of the opening of which is regulated by a valve 24, here shown as a butterfly valve located close to the mouth 22. The mixing chamber 21 shown is preferably of cylindrical formation and adapted for the passage of ample air therethrough into the intake manifold 16 without unnecessary retardation.

A nozzle 26 having its mouth or tip 28 disposed within the mixing chamber 21 serves for the delivery of fuel thereto. A nozzle 30 surrounding the nozzle 26 in spaced relation thereto provides with the nozzle 26 an annular passage for conducting gaseous fluid (preferably cylinder gases), and effecting the discharge thereof through the tip 32 into the mixing chamber 21 at a point slightly beyond the tip 28 of the fuel nozzle 26, said gaseous fluid exerting an inductive action upon the fuel for effecting the delivery thereof into the air stream in the form of a very fine mist or fog. The nozzle 26, as shown, tapers slightly at the upper portion 26^a thereof. The outer nozzle 30 likewise tapers, as shown, at the upper portion 30^a thereof, the tapering end portions 26^a, 30^a, providing therebetween an annular passage 33 of gradually decreasing cross-sectional area towards the tips, terminating in a constricted annular orifice 33^a, the tip 32 of the outer nozzle 30 extending beyond and slightly inwardly over the tip 28 of the fuel nozzle 26 to provide a circumferentially enclosed space 33^b about said tip 28.

Gaseous fluid under pressure, preferably cylinder gases, pass at high velocity through the constricted orifice 33^a past the tip 28 of the inner nozzle 26 and cause a substantial reduction of pressure within the enclosed space 33^b about the tip 28 so that the fuel is forced out through nozzle 26 by atmospheric pressure from the tank or other source. The tips 28 and 32 can be relatively adjusted to vary the constricted orifice 33^a and the size of the recess 33^b to position the parts in the most effective inductive relation.

The nozzles 26 and 30 are preferably secured in concentric relation by being received within the bore 34 formed in the wall or casting 36 forming the mixing chamber 21. The

bore 34 comprises an enlarged upper portion 38 opening into the mixing chamber 21 and receiving the lower end of the nozzle 30, and a reduced lower portion 40 receiving the lower end of the fuel nozzle 26. The enlarged portion 38 has a passage 42 extending laterally therefrom through which the gaseous fluid is conducted to the nozzle 30.

The lower end of the constricted bore portion 40 has an extension bore 44 communicating with a chamber 46 to which the fuel is delivered from a fuel supply tank 47 through the tube 47^a. The tank is shown below the discharge point of the nozzle 26, as is the case in the ordinary automobile.

At the opposite side of the chamber 46 is a bore 48 disposed in alignment with the bore portion 44, and serving as a bearing for the needle valve 50 here shown as having a tapered nose 52 adapted to be received into the passage 44 for controlling the size of the annular orifice 54 thereof, whereby to control the quantity of fuel passing thereto from the chamber 46. The needle valve 50 is designed to give the required size of opening for each position of said valve 50. The extent of opening of the annular orifice 54 is of a cross-sectional area less than that of the usual fuel orifice, particularly during the partial load ranges of engine operation when the general pressure drop in the intake into which the fuel is discharged is relatively high and as the fuel passes therethrough the fuel is subjected to a tearing or frictional action which effects an initial disintegration thereof.

The valve 50 is controlled by a pressure-responsive device or expansible-contractible member, such as the hollow bellows 56 fixed at one end. The bellows 56 is disposed within the chamber or recess 58 formed in the casting 36 and open to the atmosphere. The passage 60 provides communication between the interior of the bellows through the fixed end thereof and the mixing chamber 21 at a point sufficiently spaced from the tip of the nozzle 30 so that the interior of the bellows 56, while subject to the general pressure drop within the mixing chamber, is not appreciably affected by the localized pressure conditions about the tip 32 of said nozzle 30. The exterior of the element 56 is exposed to full atmospheric pressure.

The valve 50 is connected to the expansible-contractible element 56 to respond in synchrony with the difference between atmospheric pressure and that in the mixing chamber 21, but in a sense to increase the fuel passage opening 54 as said pressure difference decreases and vice versa. The connection comprises a lever 62 passing through the slot 63 in the outer end of the valve 50, and having a slot 64 at one end loosely receiving a pin 66 secured to the movable end of the expansible-contractible element 56, and free-

ly pivoted at the opposite end thereof upon a pivot 68. The pivot 68 is secured by means of a clamping nut 70 in adjusted position within the slot 72 of the vertical arm of the angular bracket 74, whereby to vary the leverage of the connection to permit of the adjustment of the relative movements of the expansible-contractible element 56 and the valve 50.

The fuel metering movement of the valve 50, and therewith the expansion and contraction movement of the bellows 56 is regulated by means of adjustable stops 76 and 77 disposed on the bracket 74 to engage the lever 62 at opposite sides thereof. When the bellows 56 is contracted to such extent that the lever 62 engages the stop 76, the valve 50 is in its position for minimum fuel passage. When the bellows 56 expands to the maximum extent permitted without impairment of its sensitiveness, this movement being limited by stop 77 engaging the lever 62, valve 50 is in its position for maximum fuel passage. By adjustment of stop 77 I can predetermine or fix the minimum intake pressure drop productive of movement of valve 50 to reduce the extent of opening of the fuel passage, and I preferably fix same so that valve 50 retains its maximum extent of opening at full engine load for all speeds. The horizontal arm of the bracket 74 is provided with a slot 78 receiving the pin 80 on the casting 36, whereby to adjust the bracket towards and away from the opening 54 to control the initial position of the valve 50. The bracket 74 is locked in the latter position by the clamping nut 82.

The gaseous fluid discharged at the nozzle 30 into the mixing chamber 21 in the construction shown is preferably taken from the engine cylinder or cylinders 10. The means for supplying the cylinder gases consists of a hollow pressure element 84 secured upon or formed within the head of the cylinder and surrounded by the water-containing spaces thereof for cooling the element. The outlet 86 from the cylinder through the element 84 is controlled by a pressure reducing valve 88 disposed upon the conical seat 90 within the pressure element and adapted to be lifted by the escaping cylinder gases so that the passage 86 is open at all times when the cylinder pressure exceeds the pressure on the other side of the ball. The ball 88 is freely movable except for its own weight and that of the centering sleeve 92 therefor sliding on the adjustable stem 94 and serving to limit the movement of the ball 88. The interior of the pressure element communicates through the tube 96 with the pressure equalizing chamber 98 which serves also as a condensing chamber for water contained in the cylinder gases, and as a filtering chamber for the purpose of separating the solid con-

stituents such as carbon, from the cylinder gases.

The filtering means consists of a tubular reticulated member, such as a tubular screen 100, disposed centrally within the chamber 98 in spaced relation to the walls thereof and surrounded by a tubular member or casing 102 of fibrous or porous material, such as felt. The cylinder gases passing through the tube 96 enter the outer annular portion 104 of the chamber 98 and pass through the members 100 and 102 into the inner portion 106, after being properly filtered. The cleaned and cooled cylinder gases are delivered to the nozzle 30 from the inner portion 106 through the tube 108, and fixed gases being accompanied by vapors of water condensed in chamber 98.

My novel method now can be readily understood by reference to the apparatus shown in the drawing and described above.

Air supply

Upon the completion of the exhaust piston stroke, all gases have been driven out of the cylinder except those occupying the clearance space. Upon the intake stroke of the piston, with the inlet valve open, such filling of the piston-swept space in the cylinder as takes place is produced by the atmospheric or other available exterior pressure forcing air past the air throttle, through the mixing chamber and the intake manifold and cylinder inlet ports, and finally into the cylinder region of initial low pressure. There is a graduated drop of pressure during the intake stroke all the way from the atmosphere to the cylinder, and in automobile and similar multi-cylinder engines the drop in pressure in the intake or distributing manifold, for example, tends to keep substantially constant for any particular condition of engine operation. This pressure drop increases with increase in friction and resistance to air travel.

While I keep the frictional resistance to air travel as low as possible, some friction is unavoidable. The friction and resulting pressure drop increases with increase of speed of travel of the air, that is with the engine speed and number of cylinder fillings for a given time interval. The principal factor in creating resistance to air movement from the atmosphere to the engine cylinder and communicating spaces, however, is the position of the throttle valve which with my invention is an air throttle, the fuel being supplied into the air stream between the air throttle and the engine cylinders. When the air throttle is nearly closed, for example, the pressure in the intake manifold mixing chamber at sea level is approximately five pounds per square inch, making a drop of approximately ten pounds below atmospheric pressure.

Thus the air supply and the initial cylinder pressure, that is the pressure in the cylinder

at the closing of the inlet valve, varies substantially directly with variation in the extent of opening of the air inlet passage and also has a subordinate variation substantially directly with variation in engine speed, while the general pressure drop below atmospheric in the mixing chamber (called general pressure drop to distinguish from localized pressure drop referred to below), varies substantially inversely with the extent of opening of the air inlet and substantially directly with the engine speed.

Fuel delivery to mixing chamber

The fuel nozzle is subjected to the pressure drop existing generally in the mixing chamber and to this extent atmospheric pressure is available for forcing in the fuel. With the very considerable pressure drop of as much as ten pounds per square inch, above referred to, it will be evident that fuel can be raised by the atmospheric pressure more than twenty feet, if desired, and still be discharged into the mixing chamber at a considerable velocity.

The pressure drop generally throughout the mixing chamber, however, practically vanishes under certain conditions, as for example at low piston speeds with wide open throttle. Under full engine load conditions with maximum air supply to the engine cylinders, the pressure drop generally in the mixing chamber is inconsiderable and at the same time the requirements for fuel to be mixed with the air of the charge approach the maximum. Thus the general intake depression in the mixing chamber cannot be utilized throughout the range of engine operation for raising fuel and supplying same directly to the charge without intervention of provision for temporary fuel storage as in the ordinary vacuum tank, carburetor float chamber and the like.

However, when the intake pressure drop is low, the cylinders are being supplied with full charges and the pressures and velocities at which cylinder gases are available are correspondingly increased. In order to supply fuel when the general intake pressure drop is low, therefore, the fuel nozzle is also made subject to localized pressure drop by discharge of cylinder gases into the intake in inductive relation to the fuel nozzle, said pressure drop being of magnitude dependent upon the velocity of the cylinder gases discharged into the mixing chamber and upon the particular inductive relation of the cylinder gases to the fuel nozzle.

The pressure and velocities at which cylinder gases are available are substantially maximum at full engine load, and least at idling, or when the engine is being turned over by the starting motor, though not inconsiderable even then. Thus the localized pressure drop produced by the velocity discharge of the

cylinder gases into the mixing chamber has a complementary or inverse relation to the general pressure drop in the mixing chamber, and with the fuel nozzle subjected to both the general pressure drop and this localized pressure drop, atmospheric pressure becomes available to a sufficient extent for fuel raising, and delivery thereof to the mixing chamber throughout the range of engine operation, and this to an extent which can readily be considerably in excess at all times of requirements for raising fuel through any heights encountered in automobile practice, including continuous climbing of the steepest grades, enabling vacuum tanks, fuel pumping devices, carburetor float chambers, and the like to be dispensed with.

The inductive blasting in of the fuel by the cylinder gases has also the additional advantage that the fuel is supplied in a highly comminuted state. Furthermore, instead of depending for fuel lifting on expedients such as passing the air of the charge through a Venturi throat around the fuel nozzle which tends to some extent to reduce the weight of air supplied and the initial cylinder pressure, I am enabled by the use of the cylinder gases for this purpose to obtain an advantageous increase of the weight of charge and the initial cylinder pressure.

Comminution of the fuel

Constricted intake manifolds with sharp corners, etc., have been resorted to for the purpose of imparting high velocity and considerable turbulence to the air stream carrying fuel therewith. The endeavor with this practice is to keep the fuel in the air and off the manifold walls as far as possible. While the desired result is accomplished to some extent, an enormous sacrifice of initial cylinder pressure and engine power results because of the high frictional and other retardation to travel of the charge stream.

Also application of heat has been made to the charge material, usually through a part of the manifold walls, and in this way some fuel is vaporized and kept in the air stream, but only at great sacrifice of charge density, with resulting decrease in power.

With my invention the fuel is put into and retained in thorough suspension in the air stream by first passing the fuel through a narrow metering passage and then subjecting it to the blasting and disintegrating action of the stream of cylinder gases into which it is delivered by the fuel nozzle, and the fuel in comminuted or vaporous state comparable to smoke, is mixed with the air stream so that it remains homogeneously incorporated and suspended therein without reliance upon excessive manifold velocity, or application of heat sufficient to produce impairment of volumetric efficiency; and constricted, sharp-turning manifolds, hot spots, and the like expedi-

ents can advantageously be eliminated. Even at starting, with no more than compression cylinder pressure available, the fuel disintegration is sufficient to ensure good mixtures for starting and for getting good engine operation with minimum of "warming up". Under practically all conditions of engine operation the entire body of the fuel metered including "heavy ends", and even though cold, is put into and maintained in thorough admixture with and suspension or flotation in the air. The relatively cold charge material of high density and thorough homogeneity so obtainable permits the delivery of an advantageously high weight of charge to the engine cylinders in a state adapted for securing complete combustion upon being compressed and ignited.

Fuel metering

The fuel is raised and delivered as above described by excess of atmospheric pressure over the pressure at the fuel nozzle, this pressure difference being due in part to the general pressure drop in the mixing chamber and in part to the localized pressure drop produced by velocity discharge of cylinder gases about the fuel nozzle. The quantity of fuel supplied to be delivered under the pressures so made available is controlled by regulating the extent of opening of the fuel passage so as to vary same substantially inversely to changes in the general pressure drop in the mixing chamber below atmospheric pressure.

As has been seen, this general pressure drop varies substantially inversely with extent of opening of the air inlet and consequent forcing of air therethrough under atmospheric pressure, and it also varies substantially directly with the engine speed. When the extent of fuel passage opening, therefore, is varied inversely with the general intake depression, the result is that said extent of fuel passage opening varies substantially directly with the variation in air supply. It is to be noted that at wide open throttle the slight intake depression is insufficient to produce contraction of the bellows away from the expansion stop and reduction of the extent of opening of the fuel metering passage so that ample fuel is always available at wide open throttle. The extent of opening of the fuel passage also varies substantially inversely with the engine speed, but as the velocities at which cylinder gases are available for creating localized pressure drop about the fuel nozzle vary substantially directly with the engine speed the fuel required for mixing with the air throughout is supplied by coordination of fuel passage opening and pressures available for fuel delivery.

Engine starting

When the engine is not running, the fuel valve is at its position of maximum opening.

Upon starting the engine, the first discharge of gaseous fluid through nozzle passage 30 is principally of air at the compression pressures developed by the turning over of the engine by the starting motor. The throttle being practically closed there is a resulting general pressure drop in the intake due to piston movement, and this, together with the inductive pressure drop at the fuel nozzle, is sufficient to produce fuel raising by atmospheric pressure, and the fuel is discharged in a finely divided state into admixture with the air passing the throttle. The fuel valve is moved somewhat from its initially open position, but only to the extent corresponding to the general intake pressure drop produced by the starter motor, and not sufficiently to unduly restrict the extent of opening of the fuel passage, thus insuring delivery of a sufficient quantity of fuel for easy starting. As soon as the motor begins to fire the system takes up its orderly functioning as above described.

It will be seen that by my improved method, carried out by means of apparatus such as described, the fuel required throughout the range of engine operation can be raised through a considerable height if necessary by direct application of atmospheric or other available pressure upon the surface, the extent of opening of the fuel passage and the pressures effective for delivery thereof can be inter-related so as to deliver the fuel in quantities to suit the air supply and the varying requirements of the engine, and the fuel can be blasted into and entrained in the air stream and both the fuel and air admixed into a state of thorough homogeneity and so delivered to and maintained in the engine cylinders until combustion, and that this homogenized charge material can be substantially as cold, dense and heavy as may be required, and with the provision of ample and relatively unobstructed air passages, and resort to superatmospheric driving pressure, if desired, can be delivered in full quantities; and that the various features of the invention dispense with numerous complicated arrangements heretofore in use, and enable the securing of very good combustion, power and economy.

It is to be understood that the foregoing is intended to afford an understanding of the invention, and not for limitation and that the scope of the invention is as defined in my claims.

I claim:

1. In an internal combustion engine, an intake manifold, a mixing chamber in open communication therewith, a throttle valved air inlet to said mixing chamber, a fuel conduit having a discharge orifice in said mixing chamber, a conduit for cylinder gases varying in pressure with the control of the air leading to said mixing chamber, and ter-

minating in inductive relation to said discharge orifice, the inductive effects of the cylinder gases varying directly with the variation in the air flow and substantially in inverse relation to the variations in intake depression to vary the fuel flow in inverse relation to the variations thereof induced by intake depression and means actuated by variations in the pressure drop in the mixing chamber coextensively with the variations in air supply resulting from the control thereof for metering fuel through the fuel conduit in inverse relation to the amount of pressure drop acting thereon.

2. In a multiple cylinder internal combustion engine, an intake manifold, a mixing chamber in open communication with the intake manifold, a throttled air inlet to the mixing chamber, a check valved cylinder pressure relief member in communication with certain of the engine cylinders, a fuel conduit having a discharge orifice in said mixing chamber, and a conduit leading from said pressure relief member to said mixing chamber and in inductive relation to said discharge orifice, the inductive effects of the cylinder gases varying directly with the variation in the air flow and substantially in inverse relation to the variations in intake depression to vary the fuel flow in inverse relation to the variations thereof induced by intake depression a metering valve in said fuel conduit, and an expansible-contractible member for actuating said metering valve in response to variations in pressure drop in the mixing chamber, so as to regulate the fuel supply in inverse relation to the intake depression and to correspond to the air supply.

3. In an internal combustion engine, an intake conduit, an air throttle for controlling the air supply throughout the range of engine operation, a fuel nozzle between the throttle and the inlet valve port of the engine, a nozzle for delivering cylinder gases in inductive relation to the fuel nozzle, and a check valve controlled line of communication between said last mentioned nozzle and the interior of the engine cylinder, the inductive effects of the cylinder gases varying directly with the variation in the air flow and substantially in inverse relation to the variations in intake depression to vary the fuel flow in inverse relation to the variations thereof induced by intake depression whereby fuel subject to atmospheric pressure is elevated and delivered in response to general pressure reduction in the intake conduit and pressure reduction locally about the fuel nozzle into homogeneous admixture with and suspension in the air between the air throttle and the inlet valve port, and means for controlling the passage of fuel to oppose the effects of intake depression.

4. Apparatus for supplying charges for an internal combustion engine, comprising an

intake conduit, means for controlling the admission of air thereto, fuel conducting means including a nozzle for delivering fuel to said intake conduit in the region of intake depression, means for discharging cylinder gases into said region under the pressures within the cylinder and in inductive relation to said nozzle; said fuel nozzle being exposed to general intake depression and also to cylinder gas induction, the inductive effects of the cylinder gases varying directly with the variation in the air flow and substantially in inverse relation to the variations in intake depression to vary the fuel flow in inverse relation to the variations thereof induced by intake depression whereby to elevate the fuel and discharge the same into homogeneous admixture with and suspension in the air stream, and means responding to variations in intake depression for metering the fuel in inverse relation to the intake pressure reduction variations.

5. In an internal combustion engine, a distributing manifold, a valve for controlling the air supplied to the manifold, a fuel lifting and vaporizing nozzle projecting into the manifold above said valve, a fuel supply line leading to said nozzle, a pressure line for conducting gaseous fluid under pressure also to said nozzle, the inductive action of said gaseous fluid varying directly with the air flow and in inverse relation to the variations in intake depression to vary the fuel flow in inverse relation to the variation thereof induced by intake depression and means responsive to variations of pressure within the manifold for controlling the extent of opening of the fuel passage in inverse relation to the amount of intake pressure reduction at the discharge end of the fuel line.

6. In an internal combustion engine, an intake conduit, means for controlling the passage of air through said conduit, means for conveying fuel into said conduit, a valve for controlling the extent of opening of the fuel passage, an elastic expansible-contractible element having one side thereof subject to the statical pressure reduction within said conduit between said air controlling means and the engine cylinders and the opposing side thereof subject to atmospheric pressure, and connected to said valve for actuating the same to vary the fuel passage in inverse relation to the amount of pressure reduction, and stops for limiting the movement of said valve in both directions and determining the minimum and maximum opening of the fuel passage for idling and full load operation.

7. In an internal combustion engine, an intake conduit, a throttle controlling the passage of air through said conduit in accordance with the engine load or speed, a fuel conduit having a discharge orifice subject to the intake depression in said intake conduit between said throttle and the engine

cylinders, means for conducting a gaseous fluid subject to a pressure varying inversely with the intake depression into inductive relation to said discharge orifice, valvular means for controlling the extent of opening of said fuel conduit, a pressure responsive device for actuating said valvular means, to vary the fuel passage in inverse relation to the variations in intake depression acting on the fuel and stop means for limiting the movement of said valvular means at minimum and maximum fuel passage openings.

8. In an internal combustion engine, an intake conduit, a throttle controlling the passage of air through said conduit, a fuel conduit having a discharge orifice subject to the intake depression in said intake conduit between said throttle and the engine cylinders, means for conducting a gaseous fluid subject to a pressure varying inversely with the intake depression into inductive relation to said discharge orifice, valvular means for controlling the extent of opening of said fuel conduit, a pressure responsive device, a lever connecting said pressure responsive device with said valvular means, means for adjusting the leverage of said lever to control the relative movement of said pressure responsive device and said valvular means, and adjustable stops limiting the travel of said valvular means and determining the minimum and maximum opening of the fuel passage, and also serving to prevent the movement of said pressure responsive device beyond the elastic limits thereof in order to render the same more sensitive to pressure variation.

9. The method of supplying and mixing the components of the charge material for an internal combustion engine which consists in controlling the passage of air to the cylinders, subjecting the discharge end of the fuel line to the pressure reduction in the intake beyond the point of air control and to the inductive action of a gas stream to cause a flow of fuel continuously throughout the range of operation of the engine, and modulating the fuel flow by and in inverse relation to the variations in the differential between the atmospheric pressure and the intake pressure to vary the fuel supply directly with the air supply coextensively with the extent of air control and with the extent of variation of the intake pressure reduction occurring as a result thereof.

10. The method of supplying and mixing the charge components of an internal combustion engine which consists in controlling the passage of air to the engine cylinders, subjecting the discharge end of the fuel line to the pressure reduction in the intake beyond the point of air control and to the inductive action of a gas stream for causing a flow of fuel continuously and the discharge thereof into the air stream in a finely divided

state continuously throughout the operating range of the engine, and modulating said fuel flow in inverse relation to and by the variations in said intake pressure reduction to vary the fuel supply directly with the air supply coextensively with the extent of air control and with the extent of variation of the intake pressure reduction occurring as a result thereof.

11. The method of supplying and mixing the components of the charge material for an internal combustion engine which consists in controlling the passage of air to the engine cylinders, subjecting the discharge end of the fuel line to the reduction in pressure in the intake beyond the air controlling means and to a reduction in pressure due to the inductive action of a gaseous stream varying in kinetic energy in inverse relation to the variations in intake pressure reduction occurring upon the control of the air supply, the component pressure reductions being made to complement each other in causing a flow of fuel and the discharge thereof in a finely divided state into the air stream continuously throughout the operating range of the engine, and utilizing the variations in one component pressure reduction for modulating the fuel flow while substantially excluding the variations in the second component pressure reduction from affecting said modulation, whereby to counteract the variable effect of one component pressure reduction and augment the variable effect of the other component pressure reduction at the discharge end of the fuel line on fuel flow and cause the fuel flow to vary directly with the variations in air supply resulting from the control of the passage thereof.

12. The method of supplying and mixing the components of the charge material for an internal combustion engine which consists in controlling the passage of air to the engine cylinders, subjecting the discharge end of the fuel line to the reduction in pressure in the intake beyond the air controlling means and to the inductive action of a gaseous stream varying in kinetic energy in inverse relation to the variations in intake pressure reduction occurring upon the control of the air supply, the same being made to complement each other in causing a flow of fuel and the discharge thereof in a finely divided state into the air stream continuously throughout the operating range of the engine, and utilizing the variations in the reduction in intake pressure for modulating the fuel flow in inverse relation thereto while substantially excluding the pressure variations due to the inductive effect of said gaseous stream from affecting said modulation, whereby to counteract the variable effect of the intake pressure reduction and augment the variable inductive effect of said gaseous stream at the discharge end of the fuel line on fuel flow and

cause the fuel flow to vary directly with the variations in air supply resulting from the control of the passage thereof.

13. The method of supplying and mixing the components of the charge material for an internal combustion engine which consists in controlling the passage of air to the engine cylinders in accordance with the engine load or speed, and discharging a gas stream varying in kinetic energy substantially directly with the control of the air supply into the air stream in inductive relation to the discharge end of the fuel line beyond the point of air control for supplementing intake depression beyond said point in maintaining pressure reduction below atmospheric at the discharge end of the fuel line continuously throughout the operating range of the engine of an order of magnitude to cause a continuous flow of fuel by atmospheric pressure directly from the source of supply at a level materially lower than the fuel discharge end, and controlling the passage of fuel substantially in inverse relation to the variations in intake depression effective on the fuel at the discharge end thereof.

14. The method of supplying and mixing the components of the charge material for an internal combustion engine which consists in controlling the passage of air to the engine cylinders in accordance with the engine speed or load, subjecting the discharge end of the fuel line to the intake depression beyond the point of air control and also to localized depression increasing with the decrease in intake depression upon increase of air supply by control of the passage thereof and attaining a maximum of the order of several inches of mercury when the intake depression is substantially the minimum, and causing thereby a flow of fuel under atmospheric pressure continuously throughout the operating range of the engine directly from the fuel supply tank located at a materially lower level, and controlling the fuel passage substantially in inverse relation to the variations in intake depression effective on the fuel at the discharge end thereof.

15. The method of supplying and mixing the components of the charge material for an internal combustion engine which consists in controlling the passage of air to the engine cylinders, subjecting the discharge end of the fuel line to the reduction in pressure in the intake beyond the point of air control and to the inductive action of a stream of cylinder gases at the higher pressure developed within the engine cylinder discharged into the air stream, and thereby causing a flow of fuel and the discharge thereof into the air stream in a highly comminuted state, and modulating the fuel flow coextensively with the extent of air control in inverse relation to and by the variations in the reduction in intake pressure occurring as a result thereof.

16. The method of supplying and mixing the components of the charge material for an internal combustion engine which consists in controlling the passage of air to the engine cylinders, subjecting the discharge end of the fuel line to the reduction in intake pressure beyond the point of air control, injecting cylinder gases under the pressures existing within the engine cylinders and varying directly with the control of the air supply into the air stream in inductive relation to the discharge end of the fuel line, and thereby both reducing pressure ahead of the fuel to elevate the fuel under atmospheric pressure, and disintegrating the fuel in the blast of cylinder gases into homogeneous admixtures with and diffusion in the air of the charge, and modulating the fuel flow coextensively with the extent of air control in substantially inverse relation to and by the variations in the reduction in intake pressure occurring as a result thereof.

17. The method of supplying and mixing the components of the charge material for an internal combustion engine which consists in controlling the passage of air to the engine cylinders, subjecting the discharge end of the fuel line to the reduction in intake pressure beyond the point of air control, and also to the reduction in pressure caused by the discharge of cylinder gases under the relatively high pressure available in the engine cylinders in inductive relation to said discharge end, and so relating the two sources of pressure reduction that the same vary in substantially inverse relation to each other as the air supply is varied by the control of the passage thereof.

18. The method of supplying and mixing the components of the charge material for an internal combustion engine which consists in controlling the passage of air to the engine cylinders, subjecting the discharge end of the fuel line to the intake pressure reduction beyond the point of air control and to the reduction in pressure due to the inductive effect of a gaseous stream varying in kinetic energy directly with the air supply as the same is varied by the control of the passage thereof, and as the same varies upon changes in speed occurring independently of the air control, causing the component reductions in pressure to complement each other in maintaining throughout the operating range of the engine a flow of fuel under atmospheric pressure directly from the supply tank at a materially lower level, modulating the fuel flow coextensively with the extent of air control in inverse relation to and by the variations in intake pressure reduction occurring as a result thereof, and upon variation in speed at full load utilizing the two component pressure reductions to vary the fuel flow directly with the speed.

19. The method of supplying and mixing

the components of the charge material for an internal combustion engine, which consists in controlling the passage of air to the engine cylinders, subjecting the discharge end of the fuel line to the reduction in intake pressure beyond the point of air control and to the inductive action of a gas stream varying in kinetic energy directly with the variations in air supply resulting both from the control of the passage thereof and from speed variations occurring independently of the air control, modulating the resulting fuel flow substantially coextensively with the extent of air control in inverse relation to and by the variations in intake pressure reduction resulting from said air control, and upon variations in speed at full load utilizing both the variations in intake pressure reduction and the variation in kinetic energy of said gas stream for varying the fuel flow without modulating the same in inverse relation to the variations in intake pressure reduction.

20. The method of supplying and mixing the components of the charge material for an internal combustion engine which consists in taking the gases from the cylinder of the engine under the pressures available therein, cooling said gases enroute and removing solid matter therefrom, and passing the denser gases having relatively high kinetic energy continuously into inductive relation to the discharge end of the fuel line and creating a varying localized reduction of pressure having a maximum value of the order of several inches of mercury for causing a flow of fuel and the discharge thereof in a finely divided state into the air stream from a source of supply at a materially lower level.

21. In an internal combustion engine, an intake conduit, means for controlling the passage of the component air to the engine cylinders, means for supplying the liquid fuel component to the intake conduit, means for controlling the extent of opening of the fuel supplying means, and actuating means therefor subject to the pressure variations in the intake conduit beyond the air controlling means, and having a resiliency adjusted to render the same substantially coextensively with the extent of air control responsive to the pressure variations resulting therefrom; said pressure responsive means having means for retaining the same against movement upon variations in speed at full load.

22. In an internal combustion engine, an intake conduit, means for controlling the passage of air through said conduit, a fuel supply tank having a discharge orifice at an elevation of the order of several feet above the same in exposed relation to the intake pressure reduction in the intake conduit above the throttle, and means for subjecting said discharge nozzle to the inductive action of a

gaseous stream under a relatively high pressure varying directly with the control of the passage of air, and creating a reduction in pressure at the discharge orifice complementing the intake pressure reduction as the same varies as a result of the control of the air and attaining a maximum of the order of several inches of mercury as the intake pressure reduction becomes relatively small, whereby to cause the elevation of fuel directly from said tank substantially under atmospheric pressure continuously throughout the operating range of the engine, and pressure responsive means for modulating the fuel flow coextensively with the air control in inverse relation to the variations in intake pressure reduction.

23. In an internal combustion engine, an intake conduit, a throttle, a low level fuel supply tank, a nozzle projecting into said intake conduit above the throttle and communicating with said tank, an injector nozzle surrounding said fuel nozzle in spaced relation thereto, and projecting beyond the same, a line of communication between the explosion chamber of the engine and said injector nozzle, a condensing and cooling member disposed in said line, a needle valve for controlling the extent of opening of the fuel nozzle, an elastic expansible-contractible element subject to the variations in the differential between atmospheric pressure and the intake pressure above the throttle, and adjusted to be responsive coextensively with the control of the air to the resulting variations in intake pressure, a connection between said element and said valve for controlling the extent of opening of the fuel nozzle in inverse relation to the variations in the pressure differential, and stops for limiting the movement of the valve and determining the minimum and maximum opening of the fuel passage; said pressure responsive means being retained against movement upon variations in speed at full load.

24. Method of supplying and mixing charges for internal combustion engines in which the fuel is elevated from a materially lower level and blasted into the air stream in the region of intake depression between the throttle and the engine cylinders by high pressure gases varying in pressure directly with throttle opening and discharged into the air stream in inductive relation to the discharge end of the fuel line, the pressure reduction created by said gases and the intake depression being made to complement each other to maintain fuel flow throughout the operating range of the engine, and controlling the passage of fuel substantially in inverse relation to the variations in the intake depression effective on the discharge end of the fuel line.

25. Method of supplying and mixing charges for internal combustion engines in

which the fuel is blasted into the air stream in the region of intake depression between the throttle and engine cylinders in a state of comminution by and with high pressure gases discharged into the air stream in effective inductive relation to the mouth of the fuel passage, the pressure reduction created by said gases and the intake depression being made to complement each other to maintain fuel flow throughout the operating range of the engine, and the fuel passage is varied in opening in inverse relation to the variations in the intake depression effective on the discharge end of the fuel line by and in response to fluid pressure variations developed by and varying with the engine operation.

26. Method of supplying and mixing the components of the charge material for an internal combustion engine which consists in controlling the passage of air to the cylinders, subjecting the discharge end of the fuel line to the action of pressure reduction in the intake beyond the point of air control, and to the inductive action of a gaseous stream for effecting continuous elevation of the fuel from a lower level, and the discharge thereof in a highly atomized state into the air stream, and modulating the fuel flow by and in response to fluid pressure variations obtained in engine operation while substantially excluding pressure reduction produced by said gaseous stream at the discharge end of the fuel line from affecting said modulation, whereby to counteract the effect of the variations in intake depression at the discharge end of the fuel line on fuel flow, and cause the fuel supply to vary directly with the air supply.

27. The method of supplying and mixing the components of the charge material for internal combustion engines which consists in controlling the passage of air to the engine cylinders, subjecting the discharge end of the fuel line to the reduction in pressure in the intake beyond the air controlling means and to the inductive action of a gaseous stream varying in kinetic energy in inverse relation to the variations in intake pressure reduction occurring upon the control of the air supply, the same being made to complement each other in causing a flow of fuel and the discharge thereof in a finely divided state into the air stream coextensively with the air control, and utilizing fluid pressure variations obtained in engine operation for modulating the fuel flow while substantially excluding the pressure variations due to the inductive effect of said gaseous stream from affecting said modulation, whereby upon control of the air supply to counteract the variable effect of the intake pressure reduction and augment the variable inductive effect of said gaseous stream at the discharge end of the fuel line on fuel flow and cause the fuel flow to vary directly with the variations in air supply.

28. The hereindescribed method which consists in taking the gases in certain of the cylinders of an internal combustion engine at the higher pressures developed therein during normal engine operation including those substantially in excess of maximum compression to the exclusion of the gases at lower pressure, and continuously discharging said gases in limited quantities at reduced pressure into the air stream passing toward the cylinders and in inductive relation to the discharge end of the fuel line for elevating the fuel and discharging the same into the air stream in a comminuted state, and controlling the fuel passage area in response to pressure variations.

29. The method of supplying and mixing the components of the charge material for an internal combustion engine which consists in subjecting the discharge end of the fuel line to the inductive action of a stream of cylinder gases increasing in inductive effect with the air supply substantially throughout the entire range of engine operation, and thereby elevating the fuel from a lower level and discharging the same in a finely divided state into the region of reduced pressure in the intake beyond the throttle, and augmenting the varying inductive effect of said cylinder gases throughout said range by varying the fuel passage area in response to pressure variations obtained during engine operation.

30. The hereindescribed method which consists in taking gases from certain of the cylinders of an internal combustion engine, including the gaseous products of combustion, and continuously discharging said gases in limited quantity into the air stream passing toward the cylinders and in the direction of flow thereof and in inductive relation to the discharge end of the fuel line for elevating the fuel and discharging the same into the air stream in a comminuted condition, and controlling the fuel passage area by and in response to pressure variations.

31. Method of supplying and mixing charges for internal combustion engines in which the fuel is blasted into the air stream in the region of intake depression between the throttle and engine cylinders in a state of comminution by and with high pressure gases discharged into the air stream in effective inductive relation to the mouth of the fuel passage, the inductive effect of said gases being made to vary to complement the variations in intake depression to maintain a flow of fuel throughout the range of engine operation, and the flow of fuel is varied substantially in inverse relation to the variations in the intake depression effective at the mouth of the fuel passage.

32. Method in accordance with claim 31 in which at part loads the fuel passage is varied in opening as a substantially inverse func-

tion of and by the variations in the pressure reduction in the intake.

33. Method of supplying and mixing the components of the charge material for an internal combustion engine which consists in controlling the passage of air to the cylinders, subjecting the discharge end of the fuel line to the action of pressure reduction in the intake beyond the point of air control, and to the inductive action of a gaseous stream for effecting continuous elevation of the fuel from a lower level and the discharge thereof in a highly atomized state into the air stream, and modulating the fuel flow upon control of the air supply by and in inverse relation to the variations in pressure reduction in the intake, while substantially excluding pressure reduction produced by said gaseous stream at the discharge end of the fuel line from affecting said modulation, whereby to counteract the effect of the variations in intake depression at the discharge end of the fuel line on fuel flow, and cause the fuel supply to vary directly with the air supply.

34. The method of supplying and mixing the components of the charge material for an internal combustion engine which consists in controlling the passage of air to the engine cylinders, and discharging a gas stream varying in kinetic energy substantially directly with the air supply into the air stream in inductive relation to the discharge end of the fuel line beyond the point of air control for supplementing intake depression beyond said point in maintaining pressure reduction below atmospheric at the discharge end of the fuel line continuously throughout the operating range of the engine of an order of magnitude to cause a continuous flow of fuel by atmospheric pressure directly from the source of supply at a level materially lower than the fuel discharge end, and modulating the fuel flow in inverse relation to and by the variations in pressure reduction in the intake effective on the fuel discharge end.

35. In an internal combustion engine, an intake, a mixing chamber in open communication therewith, a throttle valved air inlet to said mixing chamber, a fuel conduit having a discharge orifice in said mixing chamber, a conduit for gases varying in pressure with the control of the air leading to said mixing chamber, and terminating in inductive relation to said discharge orifice, and means responsive to pressure variations developed by and varying with the engine operation for metering fuel to the discharge orifice thereof.

36. In an internal combustion engine, an intake conduit, a throttle, a low level fuel supply tank, a nozzle projecting into said intake conduit above the throttle and communicating with said tank, an injector nozzle

in inductive relation to said fuel nozzle, a check controlled line of communication between the explosion chamber of the engine and said injector nozzle, a chamber disposed in said line for removing undesirable material from the cylinder gases, a valve for controlling the extent of opening of the fuel passage, an elastic expansible-contractible element connected to said valve subject to variations in pressure developed by and varying with engine operation, and stops for limiting the movement of the valve and determining the minimum and maximum opening of the fuel passage.

37. In apparatus for supplying and mixing charges for internal combustion engines, an intake conduit, means for controlling the passage of air through said conduit, means for conveying fuel into said conduit, a valve for controlling the extent of opening of the fuel passage, means for limiting the movement of said valve and determining the maximum and minimum fuel passage opening, and elastic means responsive to pressure variations in said intake conduit beyond said air controlling means connected to said valve for actuating the same and retained by said limiting means against movement beyond its elastic limits, said pressure responsive means having a resiliency of a value to render the same responsive, throughout the range of movement thereof, to said variations in pressure substantially over the entire range of intake pressure.

38. In apparatus for supplying and mixing charges for internal combustion engines, an intake conduit, means for controlling the passage of air through said conduit, means for conveying fuel into said conduit, a valve for controlling the extent of opening of the fuel passage, means for limiting the movement of said valve and determining the maximum and minimum fuel passage opening, an element responsive to pressure variations in said intake conduit beyond said air controlling means, and retained by said limiting means against movement beyond its elastic limits, said pressure responsive element having a resiliency for rendering the same responsive throughout the range of movement thereof to said pressure variations, and an adjustable connection between said element and said valve.

39. In a fuel supplying apparatus for internal combustion engines, fuel supplying means, a valve controlling said means, a pressure responsive device adapted to be tensioned by pressure variations for actuating said valve, a lever connection between said pressure responsive device and said valve, and stops for limiting the movement of said valve in both directions at points determining the valve openings for idling and full load operation, and for limiting the movement of the pressure responsive device, said

stops and said lever connection being relatively disposed to allow differential movement of the valve relative to the pressure responsive device.

40. In a fuel supplying apparatus for internal combustion engines, fuel supplying means, a valve controlling said means, an inherently elastic pressure responsive device adapted to be tensioned by pressure variations for actuating said valve, a lever connection between said pressure responsive device and said valve, and stops for limiting the movement of said valve in both directions at points determining the valve openings for idling and full load operation, and for limiting the movement of the pressure responsive device to retain the same within the elastic limits thereof, said stops and said lever connection being relatively disposed to allow differential movement of the valve relative to the pressure responsive device.

41. In a fuel supplying apparatus for internal combustion engines, fuel supplying means, a valve controlling said means, a resiliently controlled pressure responsive device exposed to intake depression for actuating said valve to vary the fuel passage in inverse relation to the variations in depression, a lever connection between said pressure responsive device and said valve, and stops for limiting the movement of said valve in both directions at points determining the valve openings for idling and full load operation, and for limiting the movement of the pressure responsive device, said stops and said lever connection being relatively disposed to allow differential movement of the valve relative to the pressure responsive device.

42. In a fuel supplying apparatus for internal combustion engines, fuel supplying means, a valve controlling said means, a resiliently controlled pressure responsive device exposed to intake depression for actuating said valve to vary the fuel passage in inverse relation to the variations in intake depression, a lever connection between said pressure responsive device and said valve, and stops for limiting the movement of said valve in both directions at points determining the valve openings for idling and full load operation, and for limiting the movement of the pressure responsive device to retain the same under tension in the full load position to prevent operation of the pressure responsive device, said stops and said lever connection being relatively disposed to allow differential movement of the valve relative to the pressure responsive device.

43. In apparatus for supplying and mixing charges for internal combustion engines, an intake conduit, means for controlling the passage of air through said conduit, means for conveying fuel into said conduit, a valve for controlling the extent of opening of the fuel passage, means for limiting the move-

ment of said valve and determining the maximum and minimum fuel passage opening, and elastic means responsive to pressure variations in said intake conduit beyond said air controlling means connected to said valve for actuating the same and retained by said limiting means against movement beyond its elastic limits, and, in the expanded position thereof, under initial tension, to prevent operation at full load, said pressure responsive means having a resiliency of a value to render the same responsive, throughout the range of movement thereof, to said variations in pressure substantially over the entire range of intake pressure.

44. In an internal combustion engine, an intake, a mixing chamber in open communication therewith, a throttle valved air inlet to said mixing chamber, a fuel conduit having a discharge orifice in said mixing chamber, a conduit for gases varying in pressure with the control of the air leading to said mixing chamber, and terminating in inductive relation to said discharge orifice, and means responsive to the variations in reduction of pressure in the mixing chamber for metering fuel to the discharge orifice therefor.

45. The method of supplying and mixing the components of the charge material for internal combustion engines, which consists in controlling the passage of air to the engine cylinders, subjecting the discharge end of the fuel line to pressure reduction in the intake beyond the point of air control and to the inductive action of a gas stream varying in kinetic energy directly with the variations in air supply resulting from the control thereof, modulating the resulting fuel flow approximately coextensively with the extent of air control in inverse relation to and by the variations in said pressure reduction resulting from said air control, and upon variations in speed at wide open throttle operation utilizing the variations in pressure reduction at the discharge end of the fuel line for varying the fuel flow without modulating the same in inverse relation to the variations in intake pressure reduction.

46. Method of supplying and mixing the components of the charge material for internal combustion engines which consists in controlling the passage of air to the engine cylinders, subjecting the discharge end of the fuel line to the pressure reduction in the intake beyond the point of air control and to the inductive action of a gaseous stream varying in kinetic energy with variations in engine operation and discharged into the air stream in inductive relation to the discharge end of the fuel line, the intake depression and the inductive action being made to complement each other to cause a flow of fuel and the discharge thereof in a comminuted condition into the air stream continuously throughout the operating range of the engine,

and modulating the fuel flow at fractional loads by and in inverse relation to the variations in intake pressure reduction acting on the discharge end of the fuel line.

5 47. Method of supplying and mixing the components of the charge material for internal combustion engines which consists in controlling the passage of air to the engine cylinders, subjecting the discharge end of
10 the fuel line to the pressure reduction in the intake beyond the point of air control and to the inductive action of a gaseous stream varying in kinetic energy with variations in engine operation and discharged into the
15 air stream in inductive relation to the discharge end of the fuel line, the intake depression and the inductive action being made to complement each other to cause a flow of fuel and the discharge thereof in a
20 comminuted condition into the air stream continuously throughout the operating range of the engine, and modulating the fuel flow at fractional loads by and in inverse relation to the variations in intake pressure reduction
25 acting on the discharge end of the fuel line, and upon variations in speed at wide open throttle operation utilizing the variations in intake depression and inductive action acting in the same sense for varying the fuel
30 flow substantially without allowing the inverse modulation.

48. The method of supplying and mixing the components of the charge mixture for an internal combustion engine, which consists
35 in controlling the passage of air to the engine cylinders, inducing fuel flow into said air stream beyond the point of air control by intake depression and the injecting action of a fluid discharged into the air stream in inductive
40 relation to the discharge end of the fuel line, and varying in fuel inducing effect in inverse relation to the intake depression at fractional loads as the air is varied and supplementing the intake depression
45 in fuel inducing effect at full load as the speed varies, and modulating the fuel flow at fractional loads by and in inverse relation to intake depression variations and restraining said intake depression variations from causing
50 inverse modulation of fuel flow at full load operation.

49. The method of supplying and mixing the charge components for an internal combustion engine which consists in controlling
55 the passage of air to the engine cylinders, subjecting the discharge end of the fuel line to the pressure reduction in the intake beyond the point of air control and to the action of a gas stream varying with the speed and discharged into the air stream in inductive
60 relation to the discharge end of the fuel line for causing a flow of fuel and the discharge thereof into the air stream in a finely divided state continuously throughout the operating
65 range of the engine, controlling the passage

of fuel at fractional loads to vary the flow thereof in inverse relation to the variations in the intake pressure reduction acting on the discharge end of the fuel line to vary
70 the fuel supply directly with the air supply coextensively with the extent of air control, and utilizing the variations in pressure reduction and in inductive action of the gas stream varying in the same sense as the
75 speed varies at full load for varying the fuel flow directly with the speed.

50. The method of supplying and mixing the components of the charge material for an internal combustion engine, which consists
80 in controlling the passage of air to the engine cylinders, subjecting the discharge end of the fuel line to the intake depression beyond the point of air control and to localized depression by discharging a gas stream varying in pressure with the conditions of engine
85 operation into the air stream in inductive relation to the discharge end of the fuel line, the fuel flow inducing components being made to complement each other in causing a flow of fuel and the discharge thereof in a finely divided state into the air stream continuously throughout the operating range of the engine, and utilizing the variations in certain of the fuel flow inducing components for varying the passage of the fuel substantially
90 coextensively with the extent of air control and with the extent of variation of the intake pressure reduction occurring as a result thereof in inverse relation to said variations in intake pressure reduction, whereby to counteract the variable effect of intake depression and augment the variable effect of the localized depression at the discharge end of the fuel line on fuel flow and cause the fuel flow to vary directly with the air supply as the same is varied.
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51. The method of supplying and mixing the components of the charge material for an internal combustion engine, which consists
110 in controlling the passage of air to the engine cylinders, subjecting the discharge end of the fuel line to the intake depression beyond the point of air control and to localized depression by discharging a gas stream varying in pressure with the conditions of engine
115 operation into the air stream in inductive relation to the discharge end of the fuel line, the fuel flow inducing components being made to complement each other in causing a flow of fuel and the discharge thereof in a finely divided state into the air stream continuously throughout the operating range of the engine, and utilizing the variations in certain of the fuel flow inducing components for varying the passage of the fuel substantially
120 coextensively with the extent of air control and with the extent of variation of the intake pressure reduction occurring as a result thereof in inverse relation to said variations in intake pressure reduction, whereby to
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- counteract the variable effect of intake depression and augment the variable effect of the localized depression at the discharge end of the fuel line on fuel flow and cause the fuel flow to vary directly with the air supply as the same is varied, said intake depression and said localized depression being made to vary the fuel flow directly with the speed at full load operation.
52. The method of supplying and mixing components of the charge material for an internal combustion engine, which consists in controlling the passage of air to the engine cylinders, subjecting the discharge end of the fuel line to the reduction in intake pressure beyond the point of air control, injecting gases under pressures varying directly with the control of the air supply into the air stream in inductive relation to the discharge end of the fuel line, and thereby both reducing pressure ahead of the fuel to elevate the fuel under atmospheric pressure and disintegrating the fuel in the blast of injecting gases into homogeneous admixture with and diffusion in the air of the charge, and controlling the passage of fuel coextensively with the extent of air control in substantially inverse relation to the variation in the reduction in intake pressure occurring as a result thereof.
53. The method of supplying and mixing the components of the charge material for an internal combustion engine which consists in controlling the passage of air to the engine cylinders, subjecting the discharge end of the fuel line to the reduction in intake pressure beyond the point of air control, and also to reduction in pressure caused by gases under relatively high pressure varying with the engine load and/or speed, discharged into the air stream in inductive relation to said discharge end, and so relating the two sources of pressure reduction that the same vary in substantially inverse relation to each other as the air supply is varied by the control of the passage thereof.
54. The method of supplying and mixing the components of the charge material for internal combustion engines, which consists in controlling the passage of air to the cylinders, subjecting the discharge end of the fuel line to the reduction in pressure in the intake beyond the point of air control and to the action of a gaseous stream discharged into the air stream in inductive relation to the discharge end of the fuel line, and varying in inductive action with the engine operation, the same being made to complement each other in causing a flow of fuel and the discharge thereof in a finely divided state into the air stream coextensively with the range of engine operation and utilizing fluid pressure variations developed by and varying with engine operation for varying the passage of fuel substantially in inverse relation to the variations in intake depression, whereby upon control of the air supply to counteract the variable effect of the intake pressure reduction and augment the variable inductive effect of said gaseous stream on the discharge end of the fuel line on fuel flow and cause the fuel flow to vary directly with the variations in air supply.
- In testimony whereof, I have signed my name hereto.
- ARLINGTON MOORE.

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