March 13, 1956 E. OLSON 2,737,935

CRANKCASE VENTILATOR

Filed Jan. 9, 1953 2 Sheets-Sheet 1

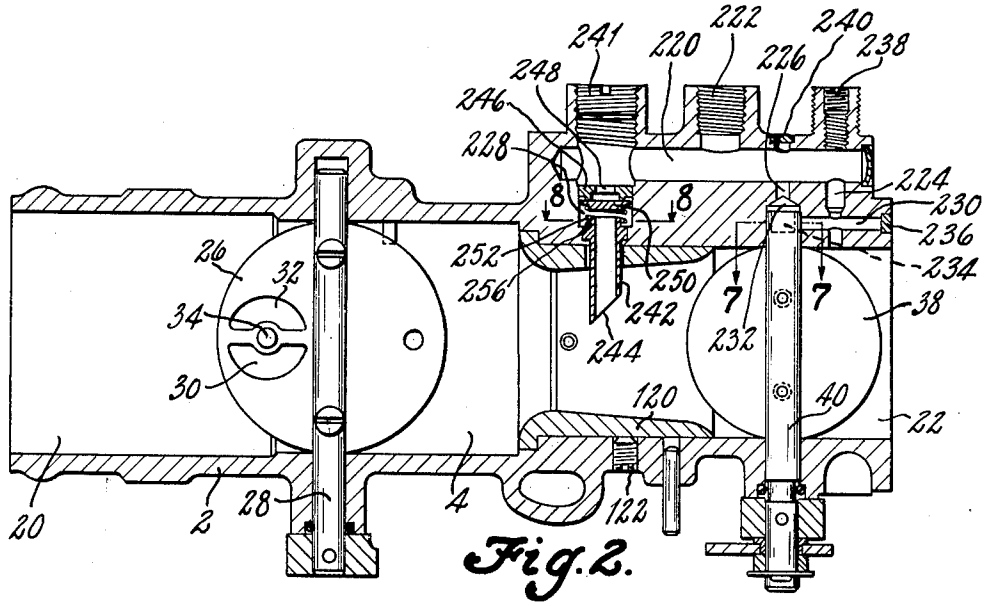

Fig. 2.

Fig. 6. Fig. 7. Fig. 8.

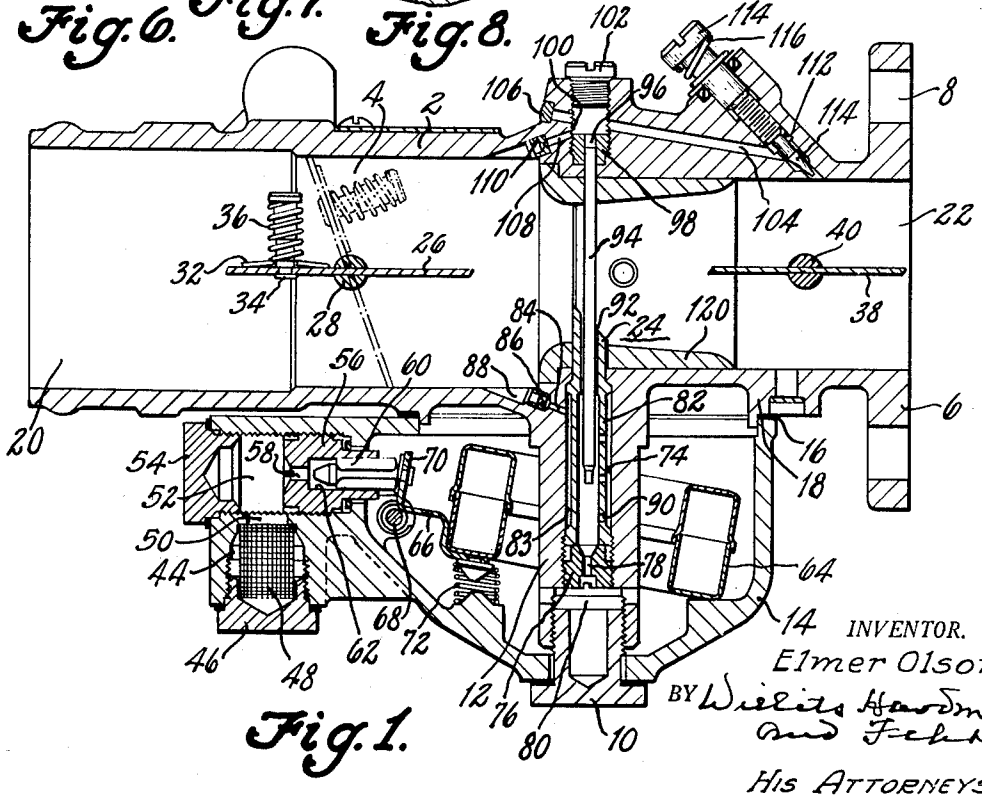

Fig. 1.

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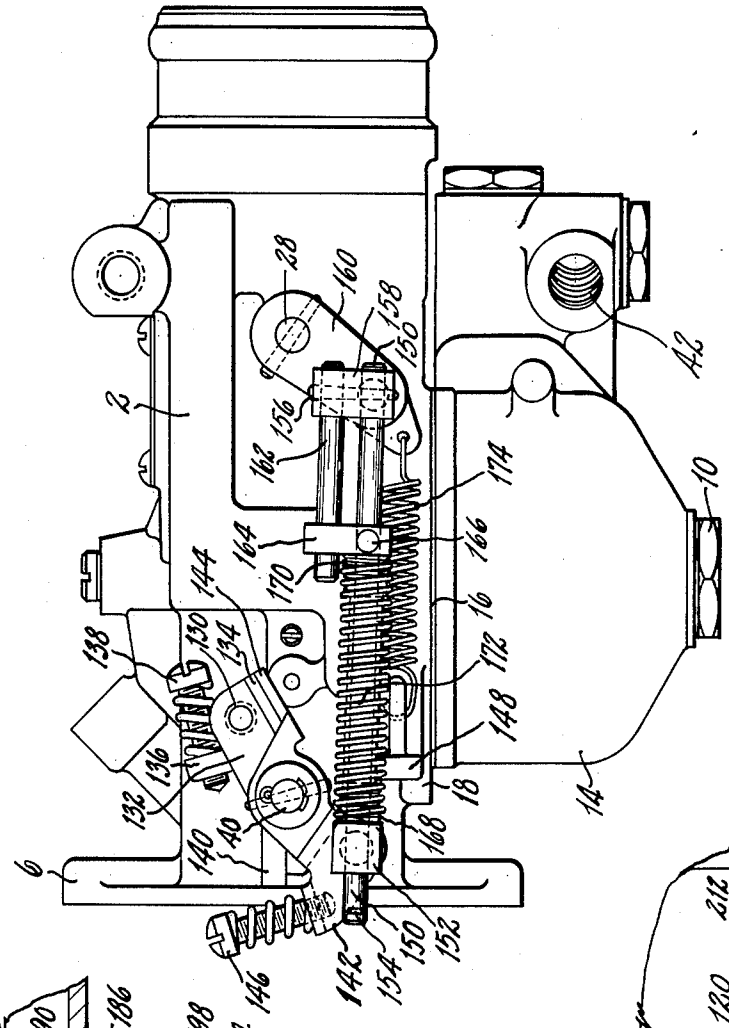

Fig. 3.

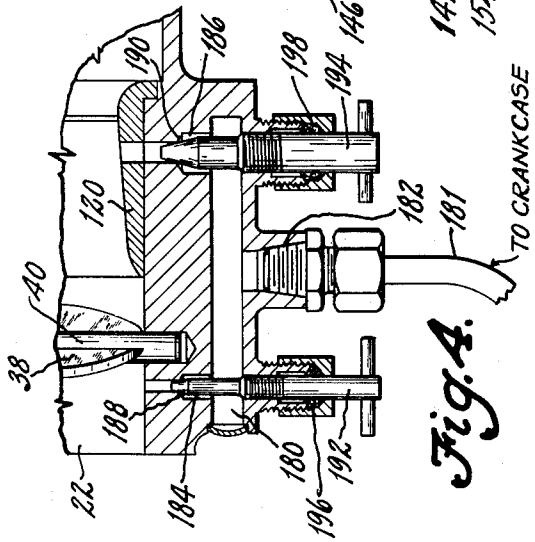

Fig. 4.

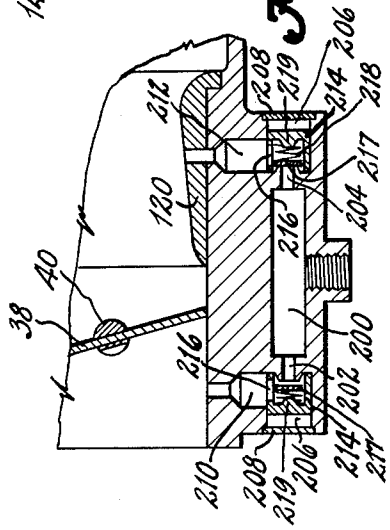

Fig. 5.

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2,737,935

CRANKCASE VENTILATOR

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Application January 9, 1953, Serial No. 330,418

16 Claims. (Cl. 123—119)

This invention relates to charge forming devices for internal combustion engines and particularly to such a device which is provided with a means to draw off vapors from the engine crank-case and to introduce such vapors into the mixture which is delivered to the engine.

It is the principal object of the present invention to utilize the suction maintained in the intake passage at points both posterior and anterior to the throttle to introduce the crank-case vapors into the intake passage posterior to the throttle when the latter approaches its closed position, to introduce such vapors anterior to the throttle when the throttle is approaching open position and to introduce such vapors on both sides of the throttle when the latter is in some intermediate position, while controlling the suction, which is effective to draw the crank-case vapors into the intake, in such a way that the quantity of vapor introduced into the mixture in all positions of the throttle will be such that a mixture of correct proportions will be supplied to the engine.

By introducing the crank-case vapors into the mixture which is supplied to the engine by the charge forming device or carburetor and properly controlling the quantity of vapor introduced under different operating conditions and at different throttle positions the maintenance of a mixture of desired proportions is facilitated. Such combustible vapor as accumulates in the crank-case is utilized in the operation of the engine, and by drawing off the vapor from the crank-case during engine operation, dilution of oil in the crank-case brought about by condensation of such vapor is minimized.

In the device disclosed herein, the object of the invention is attained by the provision of a passage in the wall of the carburetor or charge forming device which has an opening in which a conduit leading to the space in the engine crank-case is adapted to be connected. This passage connects at its ends with outlet branches leading to the mixture passage on opposite sides of the throttle valve and flow through these branches is controlled by manually adjusted or automatically operable valves, operable is response to variations in the suction in the intake passage at the points therein where the outlet branches deliver the fuel vapor, the degree of suction maintained at these points being largely controlled by the position of the throttle.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings wherein a preferred embodiment of the present invention is clearly shown.

In the drawings:

Figs. 1 and 2 are longitudinal, vertical and horizontal sections through a charge forming device in which the present invention is incorporated;

Fig. 3 is a side elevation showing the operating means for the throttle and choke valves;

Fig. 4 is a detail horizontal section of a modified

form of the means for introducing crank-case vapor into the intake passage;

Fig. 5 is another modified form of such means;

Fig. 6 is a detail plan view of a suction operated valve in the vapor supply conduit.

Figs. 7 and 8 are detail sections on the lines 7—7 and 8—8 of Fig. 2.

As shown in the drawings, the carburetor is of the horizontal type having a casting 2, in which the mixture passage 4 is formed and which has an attaching flange 6 with orifices 8 through which attaching screws are adapted to pass in the usual way. Secured by screw 10 to a depending post 12 integral with the casting 2 is a fuel chamber 14, the upper edge of which engages a gasket 16 positioned between the fuel chamber and a circular flange 18 projecting from the casting 2. The mixture passage 4 has an air inlet 20, a mixture outlet 22 and a main fuel nozzle 24.

Admission of air through inlet 20 is controlled by choke valve 26 secured to a shaft 28 suitably journalled for rotation in casting 2 and operated by mechanism described later. This valve is provided with by-pass openings 30 normally closed, a disk valve 32 mounted on a pin 34 secured to valve 26 and held in closed position by a spring 36. When the choke valve is in closed position, suction will open the small valve 32 to a variable extent against the force of spring 36 and some air will be admitted to the carburetor through the openings 30. The amount of air admitted will vary in accordance with the amount of suction effective on the valve.

The quantity of mixture which is supplied to the engine is controlled by a throttle valve 38 secured to a shaft 40 suitably journalled for rotating in the wall of casting 2 and movable to different positions by mechanism described later to vary the amount of mixture flowing through the outlet 22.

The nozzle 24 receives fuel from the float chamber 14 to which fuel is admitted through an opening 42 with which a pipe leading to a source of fuel supply is adapted to be connected. The opening 42 connects with a space 44 closed by a plug 46 and in which a screen 48 is positioned. Fuel flows from the space 44 through screen 48 and opening 50 into the bore 52 formed in casting 2 and closed by a plug 54. Screwed into bore 52 is a valve cage 56 having a fuel passage 58 controlled by a valve 60 received in a bore 62 formed in the valve and controlled by a float 64 to maintain a constant fuel level in the bowl 14. The float is attached to an arm 66 which is secured in any suitable way to a pivot 68 which is pivotally mounted in the casting. The arm 66 has an upwardly extending portion 70 which engages and operates the valve 60, closing the valve when the fuel reaches a predetermined level. A spring 72 limits the downward movement of the float.

The fuel nozzle is received in a bore 74 formed in the post 12 and is held in position by a metering plug 76 which is screwed into the bore immediately below the nozzle. A passage 78 in the metering plug receives fuel from a space 80 in the post 12 immediately above the plug 10 and to which fuel is admitted through passages 80 connecting with the space in fuel chamber 14. A portion 82 of the nozzle is smaller than the bore 74 so that there is a space 83 between this part of the nozzle and the wall of the bore. Air is admitted to this space through a passage 84 and a calibrated plug 86 positioned in a diagonal bore 88 in the wall of the mixture passage 4. A series of openings 90 in the nozzle connect the inside of the fuel nozzle with the space 83.

Extending downwardly into the nozzle 24 and slightly spaced from the inner wall thereof so as to leave a small annular space 92 for the flow of fuel, is a tube 94 which

is restricted somewhat at the bottom and at the top connects with a passage 96 in a plug 98 screwed into a bore 100 in the carburetor wall and closed at the outer end by a plug 102. The bore 100 communicates with an idling fuel passage 104 bored in the housing and closed by a plug 106, and also with an air bleed passage 108 effective to supply limited quantities of air to the bore as controlled by an air metering plug 110 similar to the plug 86.

The right end passage 104 connects with a bore 112 connecting with the mixture passage posterior to the throttle and in which is threaded a manually adjustable valve 114 to control the size of the idling fuel inlet in the usual way and held in any adjusted position by a spring 116. Fuel for idling is supplied by the passage 104 and bore 112 while the main source of fuel supply is the nozzle 24. Air is admitted to the idling fuel supply through metering plug 110 and passage 108 while air is admitted to the space 83 through plug 86 and passage 84, such air entering the main nozzle 24 through orifices 90 which are progressively uncovered as the throttle is opened and the engine speed is increased.

When the throttle is closed, all of the fuel is supplied through the idling passages. As the throttle is moved toward open position, the quantity of fuel supplied through the idling passage decreases but fuel begins to flow from the main nozzle and this flow increases as the throttle continues to move toward open position. During a part of the throttle movement both the idling and main fuel supplies function, but at some point in the throttle's opening movement the suction at the main nozzle becomes so much greater than at the idling passage, flow from the latter ceases and, instead, there is a reverse flow through such passage toward the main fuel nozzle.

The suction effective at the main nozzle is increased by the provision of a venturi tube 120 into which said nozzle discharges at the point of greatest suction therein. This venturi tube may be an integral part of the carburetor casting or a separate element as shown in the drawings, which may be held in position in any suitable way as by means of a set screw 122, for example.

The bores in which the plugs 86 and 110 are positioned connect with the mixture passage at a position immediately anterior to the intake end of the venturi tube.

The mechanism for operating the choke and throttle valves is no part of this invention but is shown in Fig. 3 and is briefly described hereinafter. As shown in Fig. 3, the parts are in the position they occupy when the throttle and choke are both open as the throttle is controlled by a governor, which, when the engine is inoperative, holds the throttle in open position through the medium of an operating rod (not shown) which is adapted to be operatively connected in any suitable way to a pin 130 projecting from an arm 132 secured to the throttle shaft 40. Arm 132 has a lug 134 which projects therefrom for a purpose later described and in another lug 136 there is threaded an adjustable stop screw 138 which is adapted to engage a stop 140 when the throttle is in fully closed position.

The governor is designed to move the throttle toward closed position if some predetermined speed is exceeded and so controls the speed of operation of the engine, but for starting purposes the choke is held closed and the throttle is moved to a nearly closed starting position by a manually operated mechanism. This mechanism includes an operating lever 142 loose on the throttle shaft and provided with a lug 144 adapted to engage the lug 134 to move the throttle toward closed position when arm 142 is moved counterclockwise. The arm carries an adjustable stop screw 146 similar to screw 138 which engages a fixed stop 148 to determine the extent of closing movement of the throttle and the starting position thereof. By adjustment of the screw the starting position of the throttle may be somewhat varied.

In order to rotate the arm 142 on the throttle shaft a rod 150 is slidable in a block 152 pivotally mounted on

arm 142 in any suitable way, and a pin 154 in the ends of the rod will engage the block if the rod moves far enough to the right relative to the block. The rod 150 at the right end is secured by a pin 156 in a block 158 pivotally mounted on an arm 160 secured to the end of the choke valve shaft 28. A short rod 162 is also secured by the pin 156 in block 158 in parallel relation to the rod 150 and another block 164 is slidably mounted on both rods 150 and 162. The block 164 has a pin 166 projecting therefrom to which some suitable manual operating connection, such as a Bowden cable, is adapted to be connected. The block 152 has a threaded extension 168 projecting to the right and the block 164 has a similar extension 170 projecting to the left, the threads of these extensions being engaged by a spring 172 which constitutes a yielding operating connection between the two blocks. A spring 174 normally holds arm 160 in the position shown in Fig. 3 to hold the choke valve open.

When the pin 166 is moved to the right by the means described, the spring 172 is tensioned and block 152 is moved to the right rotating the arm 142 counterclockwise until the stop 148 is engaged by screw 146, and this movement of the arm 142 moves the throttle to a starting position which is determined by the adjustment of stop screw 146. After movement of arm 142 stops, continued movement of pin 166 to the right will stretch the spring 172 and the block 164 may be moved into engagement with block 158 so as to move the choke valve as far toward closed position as may be desired, either fully closed or partly closed. When the operating connection to pin 166 is restored to its normal position, the governor will open the throttle and the spring 174 will open the choke valve.

As already stated, this valve operating mechanism is no part of the present invention which primarily relates to a means for withdrawing vapors from the crank-case and introducing such vapors into the mixture passage, the purpose of which is two-fold, first, to reduce the effect of oil dilution by gasoline and to assist in providing a fuel mixture of proper proportions in all throttle positions. Those different forms of a means for taking vapors from the crank-case are shown in Figs. 4, 5 and 2 and in the form shown in Fig. 4 a passage 180 is formed in a boss on the carburetor casting which has an interiorly threaded extension 182 projecting therefrom which connects with the passage 180 and with which a suitable conduit 181 leading to the space above the oil in the engine crank-case is adapted to be connected. The passage 180 connects with a bore 184 adjacent one end which connects with the mixture passage posterior to the throttle and adjacent the other end with a larger bore 186 which connects with the intake passage at a point in the venturi tube 120 relatively close to the area of highest suction therein. The delivery ends of these bores are reduced in size, forming shoulders 188 and 190 with which the tapered ends of manually operable valves 192 and 194 cooperate, respectively, to control the area of the passages through which the crank-case vapors are drawn into the mixture passage. These valves 192 and 194 are threaded in the casting, are manually adjustable to whatever position is desired, and are provided with suitable packing glands indicated generally by the numbers 196 and 198.

The operation of this device with respect to the crank-case vapors is very much like the operation of the idling and main fuel supply passages. When the throttle is closed, all of the vapors drawn into the passage 180 pass into the mixture passage through bore 184 because the suction effective at such bore is very high with closed throttle and there is substantially no suction at the delivery end of bore 186. As the throttle opens, the suction effective at the delivery end of bore 184 is reduced and that at bore 186 increases, so that flow of fuel vapor through bore 184 is correspondingly reduced and at some point in the opening movement of the throttle flow from bore 186 begins. During a part of the opening movement

of the throttle there will be a flow from both bores **184** and **186** which will continue until the suction effective at bore **186** will become so much greater than at bore **184**, flow from the latter will cease and there will be a reverse flow into bore **184** and out of bore **186**, much like the reverse flow into the idling passage **104** when the throttle is opened sufficiently. The amount of flow through the different bores at any position of the throttle can be varied by adjustment of the two valves **192** and **194**.

The device disclosed in Fig. 5 is quite similar to that disclosed in Fig. 4 except for the fact that the bores corresponding to **184** and **186** are the same size and are controlled by spring-operated check valves instead of manusually adjustable valves which are intended to remain in some selected set position. In this form of the device there is a passage **200** similar to the passage **180** which connects smaller passages **202** and **204** leading to chambers **206** of similar construction formed in the carbuetor casting and closed at the outer ends by closure plates **208**. These chambers connect with bores or passages **210** and **212**, connected to the intake passage posterior and anterior of the throttle valve, respectively. In each of the chambers **206** is a valve cage **214** having an opening **216** communicating with the bore **210** or **212** and a disk check valve **217** normally held in position to close **202** or **204** by a spring **218** positioned between the valve and the solid head **219** of the valve cage.

The operation of this device is very similar to that disclosed in Fig. 4, but for the fact that there is no means for adjusting the area of the passages delivering vapor to the mixture passage and the check valves prevent a reverse flow from the mixture passage into either passage **210** or **212**. Going from closed to open throttle there will be first a flow through bore **210** only, then through both **210** and **212** when the pressure differential across the check valve which is subject to the suction in bore **212** becomes great enough to open the valve. When the throttle gets far enough open, the pressure differential across the check valve associated with bore **210** will become insufficient to hold the check valve open, the valve will close and thereafter all flow will be through bore **212**.

In the device shown in Fig. 2 the operation of the means for taking off the crank-case vapors is controlled in part by suction and in part mechanically by the throttle shaft. A passage **220** is bored in the wall of the carburetor casting. Connecting with this passage is a threaded opening **222** with which the conduit leading to the crank-case is adapted to be connected, and on the opposite side of passage **220** three bores **224**, **226** and **228** connect with the passage **220**. The bore **224** leads to the outlet of the carburetor mixture passage posterior to the throttle valve **38** and is intersected by a bore **230** leading to the bore **232** in which the throttle shaft **40** is journalled. The bore **226** connects with the end of the bore **232** and when the throttle is in closed position a flattened surface **234** on the shaft of the throttle is in such a position that it effects communication between the bore **226** and the bore or passage **230**. The outer ends of the bores **230**, **224**, **226** and **228** are closed by closure plugs **236**, **238**, **240** and **241**, respectively.

Positioned in the bore **228** and extending into the mixture passage is a nozzle **242** which has a bevelled outlet end **244** arranged in the same way with respect to the direction of air flow, as is the main fuel nozzle. An annular collar **246** provided with a central opening **248** is fitted tightly in the bore **228** and the opening is normally closed by a valve member **250**, held in closed position by a spring **252** received between the valve and a flange **256** on said nozzle **242**. The spring holds the valve closed with a predetermined force which is overcome when the throttle is partially opened and by varying the strength of the spring which is employed, the position of the throttle at the time such spring is overcome by the force of engine suction and the valve **250** opened can be changed as desired.

In the form of the device which is shown in Fig. 2, when the throttle is in closed position, any vapors from the crank-case will be drawn off by the high suction maintained posterior to the throttle through passages **222**, **220**, **224** and **226** into the mixture passage, the passage **226** being in communication with bore **230** when the throttle is in closed position. The valve **250** will be seated at this time and no vapor will be drawn into the mixture passage through nozzle **242**. As the throttle is moved toward open position the flow of vapor from the passage **224** into the mixture passage will be progressively decreased, not only because of reduction in suction effective on the passage **224** but also because of reduction in area of the communication between passages **226** and **224**. At some point in the opening movement of the throttle while flow from passage **224** is decreasing, the suction effective on the nozzle **242** will become effective to open the valve **250** and vapor will begin to flow through nozzle **242** into the mixture passage. As the throttle continues to open, this flow will increase while that from passage **224** decreases until finally flow from **224** stops and all the flow is from nozzle **242**.

This introduction of vapor from the engine crankcase, which contains a considerable amount of vaporized fuel, can be employed, when controlled as described above, to aid in forming a fuel mixture of the proper proportions to give the best possible engine operation at idle and part throttle operation and even at wide open throttle. By introducing the vapor into the mixture passage at points both anterior and posterior to the throttle and controlling the flow into the mixture passage at these points in the manner described, these results are obtained and such results would not be possible by introducing the vapor posterior to the throttle only and controlling the introduction thereof by a throttle operated valve, as is known in the prior art.

While the embodiment of the present invention as herein disclosed constitutes a preferred form, it is to be understood that other forms might be adopted.

What is claimed is as follows:

1. In a charge forming device for internal combustion engines having an intake passage therein and provided with an outlet for delivering fuel mixture to the engine, fuel and air inlets for supplying fuel and air to the intake passage to form a combustible mixture therein and a throttle valve for controlling the flow of mixture through said outlet to regulate the quantity of mixture supplied to the engine, means for conveying vapor from the engine crank-case to said charge forming device and for introducing such mixture into said intake passage, said means including a passage having branches connecting with said intake passage both posterior and anterior to said throttle valve, a conduit connected to said last-named passage and leading to the engine crank-case, and means for independently controlling the flow from the last-named passage into the intake passage through both of said branches.

2. In a charge forming device for internal combustion engines having an intake passage therein and provided with an outlet for delivering fuel mixture to the engine, fuel and air inlets for supplying fuel and air to the intake passage to form a combustible mixture therein and a throttle valve for controlling the flow of mixture through said outlet to regulate the quantity of mixture supplied to the engine, means for conveying vapor from the engine crank-case to said charge forming device and for introducing such mixture into said intake passage, said means including a passage having branches connecting with said intake passage both posterior and anterior to said throttle valve, a conduit connected to said last-named passage at a point between said branches and leading to the engine crank-case, and independently adjustable valves for regulating the flow through said branches.

3. In a charge forming device for internal combustion

engines having an intake passage therein and provided with an outlet for delivering fuel mixture to the engine, fuel and air inlets for supplying fuel and air to the intake passage to form a combustible mixture therein and a throttle valve for controlling the flow of mixture through said outlet to regulate the quantity of mixture supplied to the engine, means for conveying vapor from the engine crank-case to said charge forming device and for introducing such mixture into said intake passage, said means including a passage having branches connecting with said intake passage both posterior and anterior to said throttle valve, a conduit connected to said last-named passage at a point between said branches and leading to the engine crank-case, valve seats in each of said branches, and independently adjustable valves cooperating therewith to variably control the flow through said branches.

4. In a charge forming device for internal combustion engines having an intake passage therein and provided with an outlet for delivering fuel mixture to the engine, fuel and air inlets for supplying fuel and air to the intake passage to form a combustible mixture therein and a throttle valve for controlling the flow of mixture through said outlet to regulate the quantity of mixture supplied to the engine, means for conveying vapor from the engine crank-case to said charge forming device and for introducing such mixture into said intake passage, said means including a passage having branches connecting with said intake passage both posterior and anterior to said throttle valve, a conduit connected to said last-named passage at a point between said branches and leading to the engine crank-case, valve seats in each of said branches, and manually operable, independently adjustable valves cooperating therewith to variably control the flow through said branches.

5. In a charge forming device for internal combustion engines having an intake passage therein and provided with an outlet for delivering fuel mixture to the engine, fuel and air inlets for supplying fuel and air to the intake passage to form a combustible mixture therein and a throttle valve for controlling the flow of mixture through said outlet to regulate the quantity of mixture supplied to the engine, means for conveying vapor from the engine crank-case to said charge forming device and for introducing such mixture into said intake passage, said means including a passage having branches connecting with said intake passage both posterior and anterior to said throttle valve, a conduit connected to said last-named passages at a point between said branches and leading to the engine intake, and means for controlling the suction communicated to said conduit through the outlet branches.

6. In a charge forming device for internal combustion engines having an intake passage therein and provided with an outlet for delivering fuel mixture to the engine, fuel and air inlets for supplying fuel and air to the intake passage to form a combustible mixture therein and a throttle valve for controlling the flow of mixture through said outlet to regulate the quantity of mixture supplied to the engine, means for conveying vapor from the engine crank-case to said charge forming device and for introducing such mixture into said intake passage, said means including a passage having branches connecting with said intake passage both posterior and anterior to said throttle valve, a conduit connected to said last-named passage at a point between said branches and leading to the engine intake, and automatically operable valves for controlling the flow from said passage into said outlet branches.

7. In a charge forming device for internal combustion engines having an intake passage therein and provided with an outlet for delivering fuel mixture to the engine, fuel and air inlets for supplying fuel and air to the intake passage to form a combustible mixture therein and a throttle valve for controlling the flow of mixture through said outlet to regulate the quantity of mixture supplied to the engine, means for conveying vapor from the engine crank-case to said charge forming device and for introducing such mixture into said intake passage, said means including a passage having branches connecting with said intake passage both posterior and anterior to said throttle valve, a conduit connected to said last-named passage at a point between said branches and leading to the engine intake, normally closed valves adapted to be opened by engine suction for controlling the flow from said passage into the outlet branches, said valve being subject to the suction in the intake passage posterior and anterior to the throttle whereby the opening of said valves is controlled by the position of the throttle.

8. In a charge forming device for internal combustion engines having an intake passage therein and provided with an outlet for delivering fuel mixture to the engine, fuel and air inlets for supplying fuel and air to the intake passage to form a combustible mixture therein and a throttle valve for controlling the flow of mixture through said outlet to regulate the quantity of mixture supplied to the engine, means for conveying vapor from the engine crank-case to said charge forming device and for introducing such mixture into said intake passage, said means including a passage having branches connecting with said intake passage both posterior and anterior to said throttle valve, a conduit connected to said last-named passage at a point between said branches and leading to the engine intake, valves controlling the flow from said passage into said outlet branches and suction maintained in said outlet branches, springs for normally holding said valves closed, the suction effective on said valves being controlled by the position of the throttle whereby the opening of said valves is determined by throttle position.

9. In a charge forming device for internal combustion engines having an intake passage therein and provided with an outlet for delivering fuel mixture to the engine, fuel and air inlets for supplying fuel and air to the intake passage to form a combustible mixture therein and a throttle valve for controlling the flow of mixture through said outlet to regulate the quantity of mixture supplied to the engine, means for conveying vapor from the engine crank-case to said charge forming device and for introducing such mixture into said intake passage, said means including a passage having branches connecting with said intake passage both posterior and anterior to said throttle valve, a conduit connected to said last-named passages at a point between said branches and leading to the engine intake, automatically operable valves for controlling the flow from said passage into the outlet branches, and means whereby the valve controlling the outlet branch which is posterior to the throttle is opened as the throttle approaches closed position and the other valve is opened as the throttle approaches open position, said last-named means being effective to bring about the openin of both valves at some intermediate position of the throttle.

10. In a charge forming device for internal combustion engines having an intake passage therein and provided with an outlet for delivering fuel mixture to the engine, fuel and air inlets for supplying fuel and air to the intake passage to form a combustible mixture therein and a throttle valve for controlling the flow of mixture through said outlet to regulate the quantity of mixture supplied to the engine, means for conveying vapor from the engine crank-case to said charge forming device and for introducing such mixture into said intake passage, said means including a passage having branches connecting with said intake passage both posterior and anterior to said throttle valve, a conduit connected to said last-named passage at a point between said branches and leading to the engine intake, normally closed suction operated valves for controlling the flow from said passage into the outlet branches, said throttle being operative to so control the suction effective on said valves

that as the throttle approaches either open or closed position one of said valves is held open and the other closed while in some intermediate position of the throttle both of said valves are held open.

11. In a charge forming device for internal combustion engines having an intake passage therein and provided with an outlet for delivering fuel mixture to the engine, fuel and air inlets for supplying fuel and air to the intake passage to form a combustible mixture therein and a throttle valve for controlling the flow of mixture through said outlet to regulate the quantity of mixture supplied to the engine, means for conveying vapor from the engine crank-case to said charge forming device and for introducing such mixture into said intake passage, said means including a passage having branches connecting with said intake passage both posterior and anterior to said throttle valve, a conduit connected to said last-named passages at a point between said branches and leading to the engine intake, an automatically operated valve controlling the flow through the outlet branch located anterior to the throttle and a valve operable by the throttle for controlling the flow through the outlet branch posterior thereto.

12. In a charge forming device for internal combustion engines having an intake passage therein and provided with an outlet for delivering fuel mixture to the engine, fuel and air inlets for supplying fuel and air to the intake passage to form a combustible mixture therein and a throttle valve for controlling the flow of mixture through said outlet to regulate the quantity of mixture supplied to the engine, means for conveying vapor from the engine crank-case to said charge forming device and for introducing such mixture into said intake passage, said means including a passage having branches connecting with said intake passage both posterior and anterior to said throttle valve, a conduit connected to said last-named passage at a point between said branches and leading to the engine intake, a normally closed suction operated valve in the outlet branch anterior to the throttle adapted to be opened by suction as the throttle approaches open position, and a throttle operated valve in the outlet branch posterior to the throttle.

13. In a charge forming device for internal combustion engines having an intake passage therein and provided with an outlet for delivering fuel mixture to the engine, fuel and air inlets for supplying fuel and air to the intake passage to form a combustible mixture therein and a throttle valve for controlling the flow of mixture through said outlet to regulate the quantity of mixture supplied to the engine, means for conveying vapor from the engine crank-case to said charge forming device and for introducing such mixture into said intake passage, said means including a passage having an outlet branch connecting with said intake passage anterior to the throttle, two outlet branches connecting with the intake posterior to the throttle, means operable by the throttle for controlling the flow through one of the last-named outlet branches, and a conduit connecting with said last-named passage and leading to the engine crank-case.

14. In a charge forming device for internal combustion engines having an intake passage therein and provided with an outlet for delivering fuel mixture to the engine, fuel and air inlets for supplying fuel and air to the intake passage to form a combustible mixture therein and a throttle valve for controlling the flow of mixture through said outlet to regulate the quantity of mixture supplied to the engine, means for conveying vapor from the engine crank-case to said charge forming device and for introducing such mixture into said intake passage, said means including a passage having a valve controlled outlet branch connecting with said intake passage anterior to the throttle, two outlet branches connecting with said intake passage posterior to the throttle, one of said last-named outlet branches being of constant area, a throttle operated valve controlling the other of said outlet branches and a conduit connecting with said last-named passage and leading to the engine crank-case.

15. In a charge forming device for internal combustion engines having an intake passage therein and provided with an outlet for delivering fuel mixture to the engine, fuel and air inlets for supplying fuel and air to the intake passage to form a combustible mixture therein and a throttle valve for controlling the flow of mixture through said outlet to regulate the quantity of mixture supplied to the engine, means for conveying vapor from the engine crank-case to said charge forming device and for introducing such mixture into said intake passage, said means including a passage having an outlet branch connecting with the intake passage anterior to the throttle, a suction operated valve therein adapted to be opened only as the throttle approaches open position, two outlet branches connecting with said intake passage posterior to the throttle, one of said branches being of constant area and a throttle operated valve in said other outlet branch movable to open position as the throttle approaches closed position, and a conduit connected with said last-named passage and leading to the engine crank-case.

16. In a charge forming device for internal combustion engines having an intake passage therein and provided with an outlet for delivering fuel mixture to the engine, a venturi tube in the intake passage, a main fuel inlet adjacent the point of greatest restriction in said venturi tube for supplying fuel to said intake passage, an idling fuel passage for supplying fuel to the intake passage posterior to the throttle, a conduit conveying fuel from said main fuel inlet to said idling fuel passage, passages supplying air to said main fuel inlet and idling fuel passages, said passages connecting with the intake passage at a point immediately anterior to the venturi tube, means for introducing vapors from the engine crank-case into said intake passage including a nozzle projecting into said venturi tube at a point of less restriction than at the main fuel inlet, a passage communicating with said nozzle and connecting with a conduit leading to the engine crank-case and another passage connecting with said last-named passage and with said intake passage, said last-named passage being adapted to deliver vapor from the crank-case to the intake passage when the idling fuel supply is effective and said nozzle being effective to deliver such vapor to the intake passage when the main fuel supply is effective.

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