April 25, 1933. C. E. WILLIAMS 1,905,258

CARBURETOR

Filed May 12, 1928 5 Sheets-Sheet 1

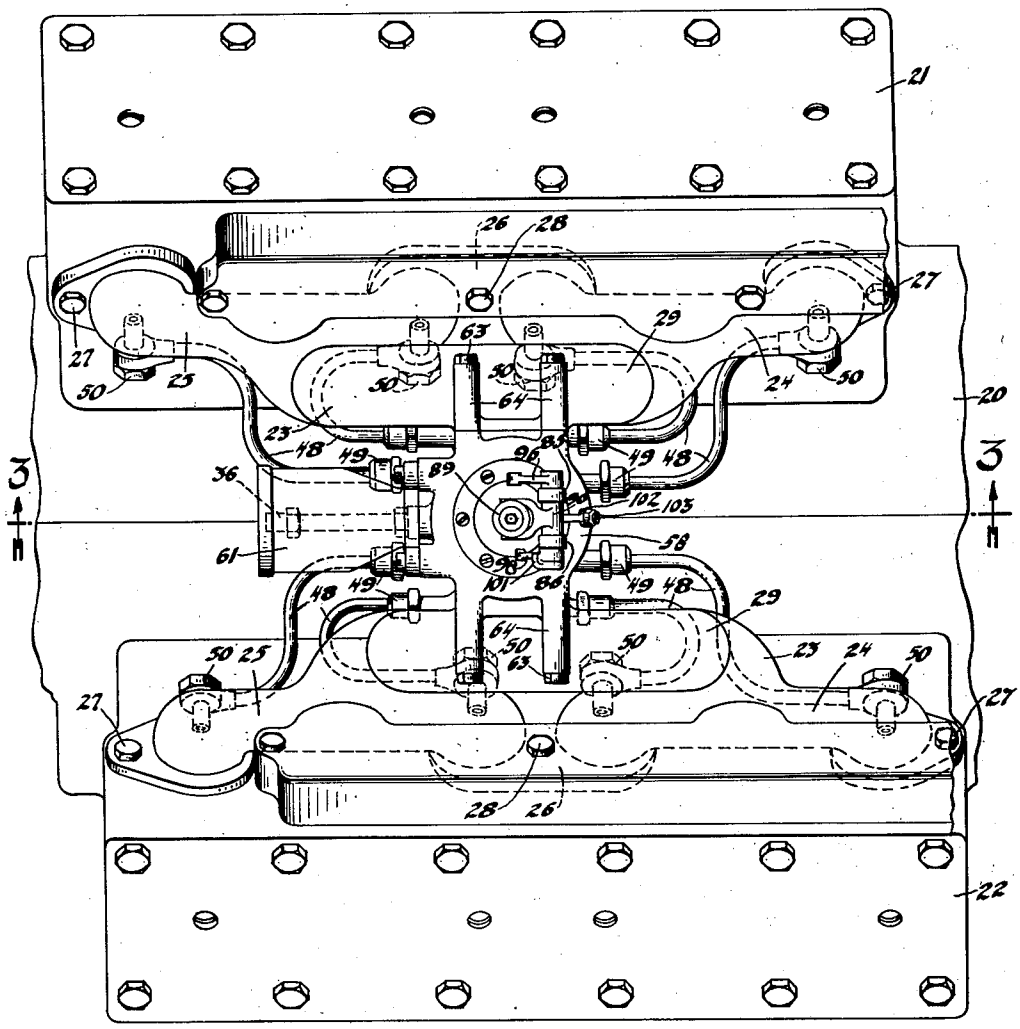


Fig. 1

Inventor
Charles E. Williams

By Blackmore, Spencer & Fleischer
Attorneys

April 25, 1933. C. E. WILLIAMS 1,905,258

CARBURETOR

Filed May 12, 1928 5 Sheets-Sheet 2

Fig. 2

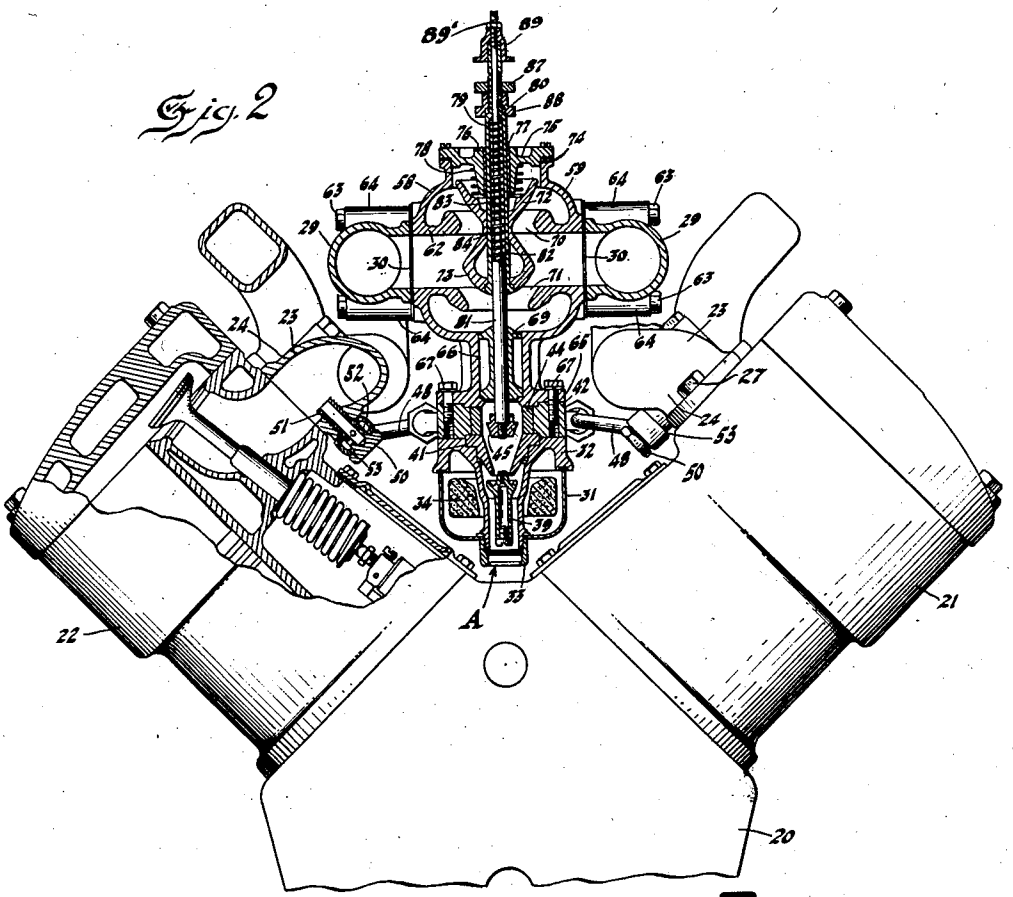
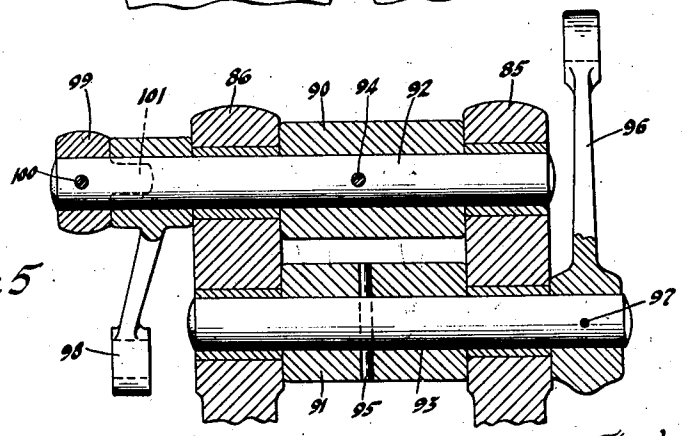


Fig. 5



Inventor

Charles E. Williams

By Blackmore, Spencer & Flich

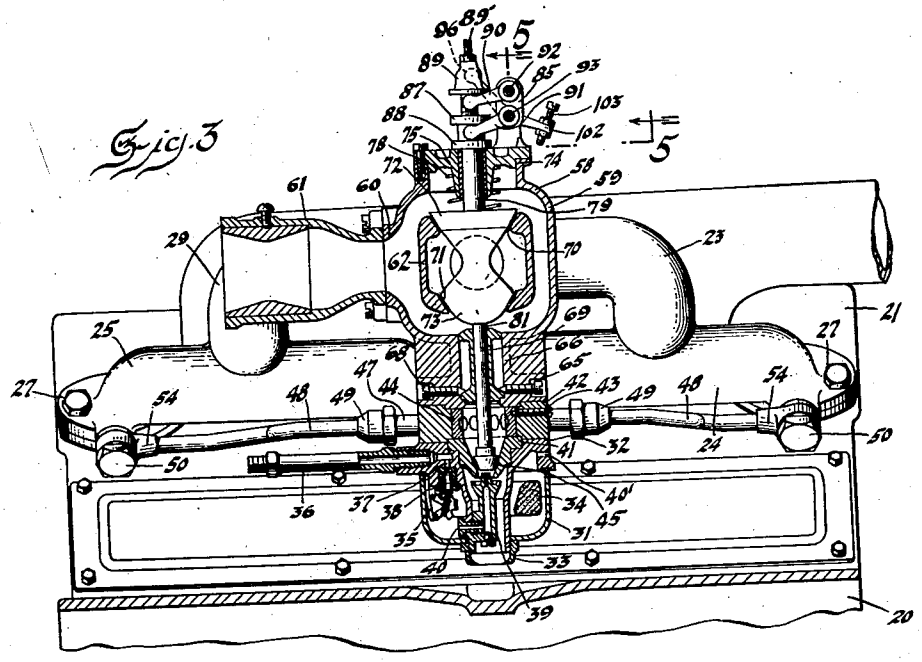
Attorneys

April 25, 1933. C. E. WILLIAMS 1,905,258

CARBURETOR

Filed May 12, 1928 5 Sheets-Sheet 3

Fig. 3



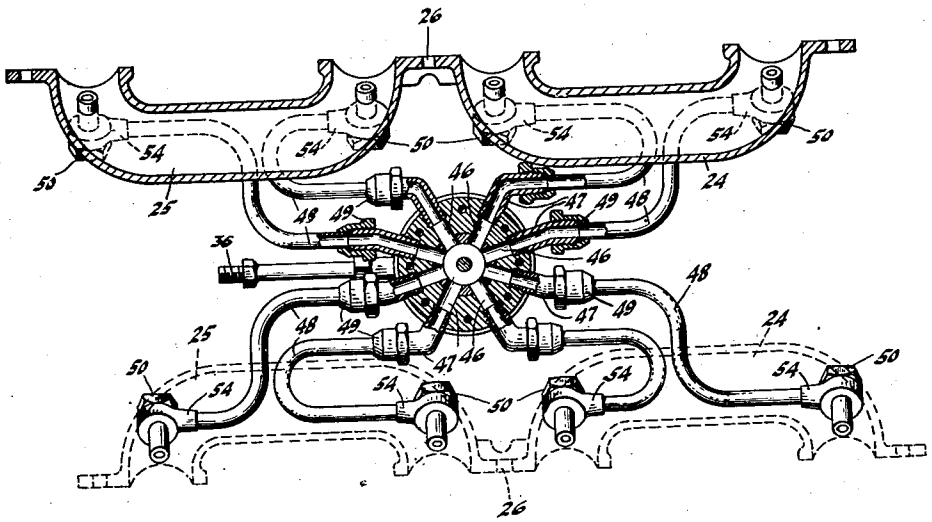


Fig. 4

Inventor
Charles E. Williams

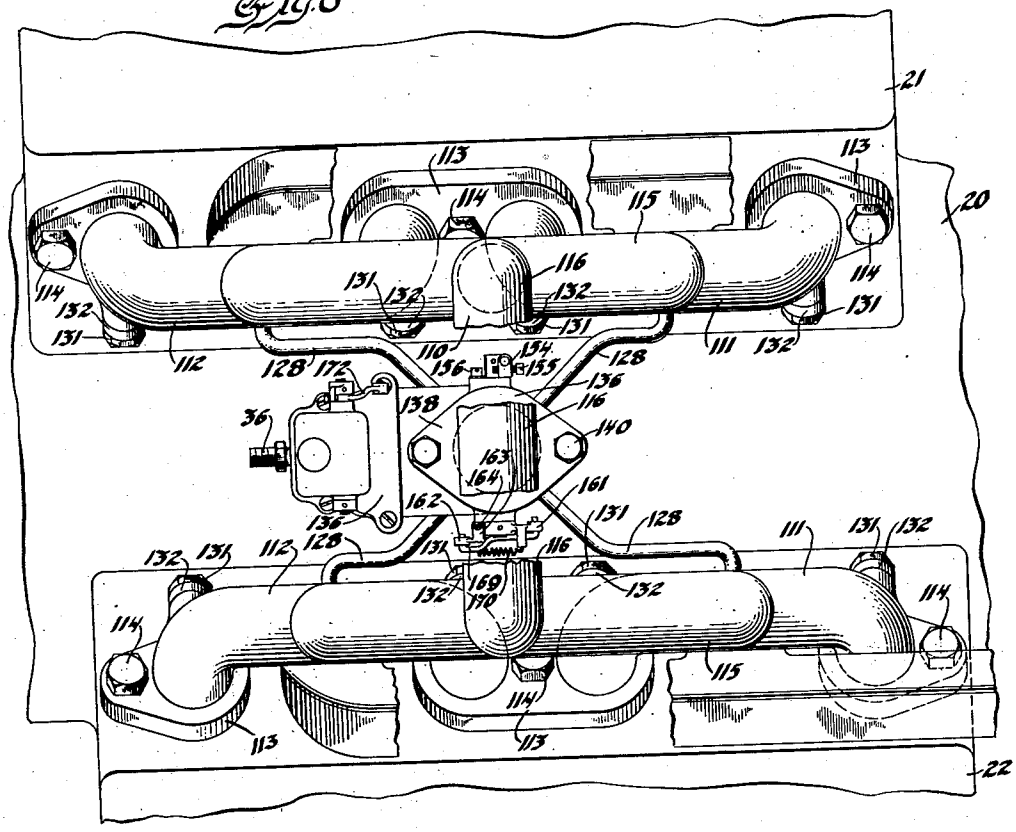
By Blackmore, Spencer & Hall
Attorneys

April 25, 1933. C. E. WILLIAMS 1,905,258

CARBURETOR

Filed May 12, 1928 5 Sheets-Sheet 4

Fig. 6



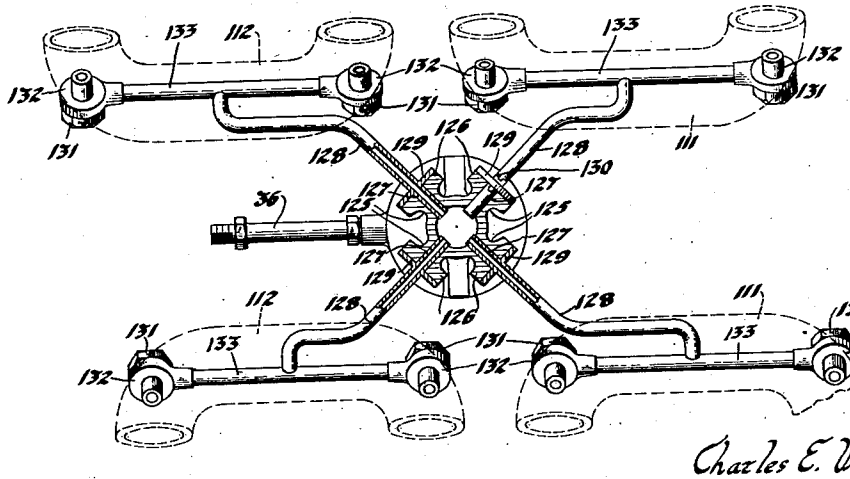


Fig. 9

Inventor

Charles E. Williams

By Blackmore, Spencer & Hill

Attorneys

April 25, 1933. C. E. WILLIAMS 1,905,258

CARBURETOR

Filed May 12, 1928 5 Sheets-Sheet 5

Fig. 7

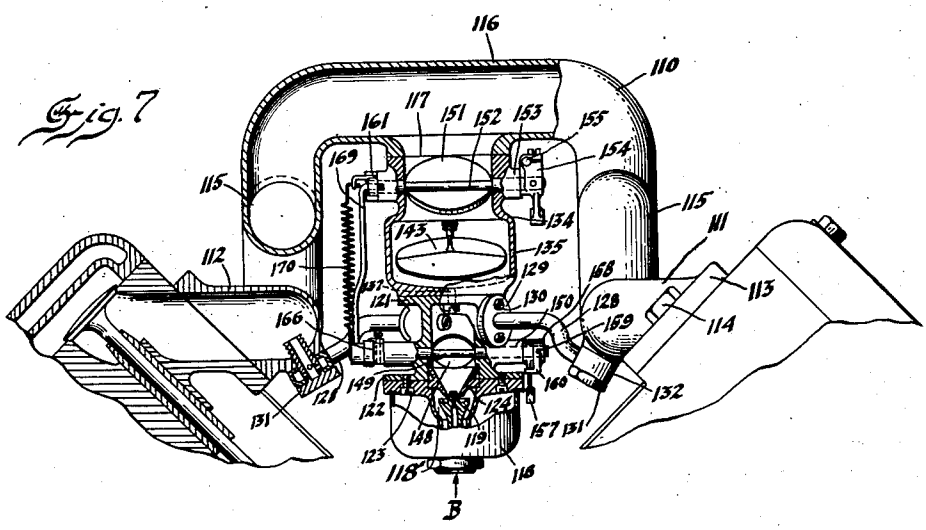


Fig. 8

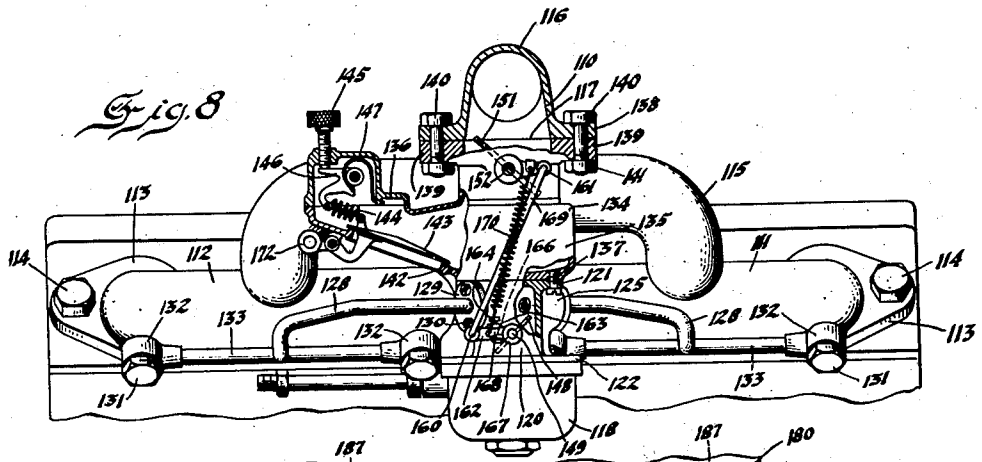
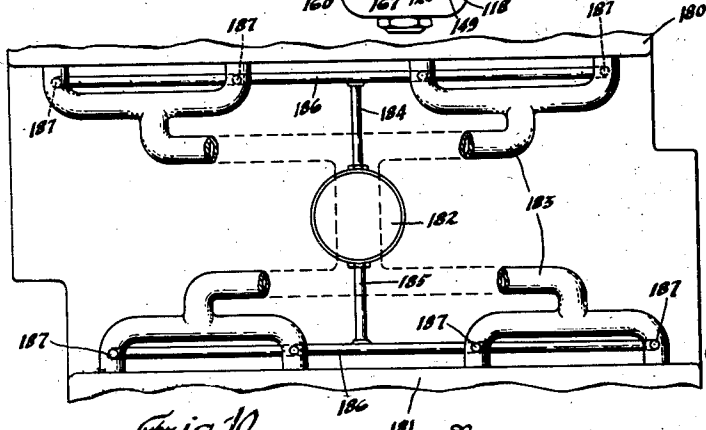


Fig. 10



Inventor
Charles E. Williams

By Blackwood, Spencer & Fuidi
Attorneys

Patented Apr. 25, 1933

1,905,258

UNITED STATES PATENT OFFICE

CHARLES E. WILLIAMS, OF DETROIT, MICHIGAN, ASSIGNOR TO GENERAL MOTORS CORPORATION, OF DETROIT, MICHIGAN, A CORPORATION OF DELAWARE

CARBURETOR

Application filed May 12, 1928. Serial No. 277,277.

This invention relates to a charge forming device for supplying a combustible mixture of fuel and air to the cylinders of an internal combustion engine.

It is an object of this invention to provide a new and improved charge forming device.

With the ordinary type of charge forming device, it has been found difficult to supply equal charges of combustible mixture of uniform composition to each of the cylinders of an internal combustion engine, particularly, when the engine is cold or is running at low speeds. This difficulty is caused to a great extent by the fact that due to the cold, or the slow speed at which the mixture travels in the conduits leading from the mixing chamber to the engine cylinders, a considerable proportion of the fuel is precipitated on the walls of the conduits. The precipitated fuel collects on the walls of the conduits until a certain amount has accumulated and is then swept, all at one time, into the combustion chambers. Thus, alternately, very lean and very rich mixtures are supplied to the combustion chambers which results in what is commonly known as "bucking" of the engine.

To overcome this difficulty, heating of the combustible mixture has, in some cases, been resorted to. While heating of the mixture results in easier starting and smoother running, it also causes expansion of the mixture with the result that charges of smaller weight are introduced into the combustion chambers, with a corresponding decrease in power.

It is an object of this invention to provide a charge forming device which will supply equal charges of combustible mixture of uniform composition to each of the several cylinders of an internal combustion engine under all operating conditions without the application of heat either to the fuel before it is mixed with the air or to the fuel and air mixture.

I accomplish this by providing a charge forming device including a carburetor having separate primary mixture and secondary air intake chambers, the latter being connected to the intake ports of the engine by an intake manifold. From the primary mixture chamber, wherein the primary air is mixed with the fuel, small pipes extend and open into the intake manifold adjacent each intake port of the engine. Through these pipes, the primary mixture passes from the primary mixture chamber and into the manifold. Secondary air passes through the secondary air chamber and into the manifold, mixing with the rich primary mixture adjacent the engine ports to form a combustible mixture of the proper proportions which passes through the intake ports into the cylinders of the engine. The primary mixture pipes, being at all times subject to the high manifold vacuum, the primary mixture flows therethrough at high velocity which prevents precipitation of the liquid fuel on the walls of the pipes.

Other objects of the invention will be apparent from a perusal of the following specification in which the embodiments of my invention shown in the accompanying drawings are described.

In the drawings:

Figure 1 is a top plan view of one form of my charge forming device installed on an eight-cylinder, V-type, internal combustion engine.

Figure 2 is a view of the installation shown in Figure 1, the engine being shown in end elevation with parts broken away and in section, and the carburetor being shown in transverse cross section.

Figure 3 is a section taken substantially on the line 3—3 of Figure 1.

Figure 4 is a more or less diagrammatic view of the connection of the primary mixture pipes to the carburetor and to the manifold in the installation shown in Figures 1—3.

Figure 5 is an enlarged fragmentary section taken on the line 5—5 of Figure 3.

Figure 6 is a top plan view, with parts broken away, of a slightly modified form of charge forming device installed on the same type of engine as shown in Figure 1.

Figure 7 is a view, partly in elevation and partly in transverse cross section, of the installation shown in Figure 6.

Figure 8 is a side view of the installation shown in Figures 6 and 7 with the left hand block (Figure 7) removed and parts of the

carburetor and manifold broken away and in section.

Figure 9 is a more or less diagrammatic view of the connection of the primary mixture pipes to the carburetor and to the manifold in the installation shown in Figures 6—8.

Figure 10 is a diagrammatic view of the arrangement of a modified type of primary mixture connections between the carburetor and the intake manifold of an eight-cylinder, V-type, internal combustion engine.

Referring to Figures 1—5 of the drawings, the reference character 20 indicates the crankcase of an internal combustion engine on which are mounted at a right angle to each other two cylinder blocks 21 and 22, each containing four cylinders.

The intake manifold 23 is made in two sections, one of which is secured to the inner side of each cylinder block. As the two sections are similar, a description of one will suffice for the other. Each section includes a conduit 24 which opens at its forward end into the front intake port in the block and at its rear end into the second intake port therein and a conduit 25 united to the conduit 24 by a web 26 and opening at its forward end into the third intake port and at its rear end into the fourth intake port in the block. Screws 27 extend through flanges on each of the conduits 24 and 25 and into the block and a screw 28 extends through each of the webs 26 and into the block, securing the conduits tightly to the block. A riser 29 opens at one end into the upper side of the conduit 24 and at its other end into the upper side of the conduit 25. As is shown in Figures 1 and 2, the risers 29 are spaced apart and are provided with opposed openings 30 in their adjacent sides.

In the space between the two cylinder blocks is positioned a carburetor which includes a float bowl which is made of two interfitting parts 31 and 32 secured together by the nut 33 and so shaped as to provide an annular fuel reservoir whose inner wall surrounds the primary air passage which is open at its lower end to the atmosphere and extends upwardly through the center of the float bowl. Fuel is supplied to the annular reservoir from the supply tank through the pipe 36 which opens into the interior thereof through the orifice 37 and is maintained at a constant level therein by the float 34 which operates the valve 38 which controls the orifice 37 through suitable mechanism, such as that indicated at 35. Within the primary air passage and spaced circumferentially therefrom is the fuel nozzle 39 which is supplied with fuel from the annular reservoir through the short pipe 40. An opening 40′ is provided in the side of the annular reservoir to maintain the pressure therein at atmospheric. A strangle tube 41 is positioned within the passage surrounded by the float bowl with its upper end seated in a rabbet in the top of the part 32 and with its lower, restricted end projecting downwardly below the top of and surrounding but circumferentially spaced from the discharge end of the nozzle 39.

Seated partially on top of the member 32 and partially on top of the strangle tube 41 is an annulus 42 which is secured to the member 32 by any suitable means, such as screws extending through one of the parts and threaded into the other. Seated on top of the strangle tube and fitting tightly within the annulus 42 and secured to the latter by the screws 43 which prevent relative movement of the two annuli is a smaller annulus 44. The space between the upper end of the nozzle 39 and the upper end of the annulus 42 which is surrounded by the strangle tube 41 and the annulus 44 forms the primary mixing chamber. Within this chamber is located the frusto-conical valve 45 which is adapted to be moved toward or away from its seat in the strangle tube by mechanism hereinafter described to control the admission of fuel and air to the primary mixing chamber.

Eight equally spaced passages 46 extend radially outwardly from the primary mixing chamber through the annulus 44 and the annulus 42. An elbow 47 is threaded into the outer end of each of these openings and is connected to a pipe 48 by means of coupling 49.

The reference character 50 indicates a nozzle (see particularly Figure 2) which is shaped like a screw having a hollow shank 51 and openings 52 in the shank adjacent the head leading from the outside of the shank to the bore therein. Two of these nozzles 50 are threaded into the under side of each of the conduits 24 and 25, each nozzle opening into the conduit as close as practicable to one of the intake ports in the cylinder block. Clamped tightly between the head of each of the nozzles and the conduit is a member 53 having a hollow annular portion which surrounds the portion of the shank of the nozzle adjacent the head and communicates with the interior of the nozzle through the openings 52 and a drawn-out portion 54 having an opening therethrough communicating with the hollow annular portion. Each of the pipes 48 is secured to the drawn-out portion 54 of one of the members 53 with its bore communicating with the opening in the drawn-out portion.

The secondary air inlet chamber 58, which, as is apparent from the drawings, does not communicate with the primary mixture chamber, consists of a shell 59 which opens at 60 into an air intake conduit 61. Integral with the shell 59, extending through it at a right angle to the direction of the conduit 61, and spaced from it intermediate its ends, is a conduit 62 which opens at its opposite

ends into the openings 30 in the risers 29. The secondary air inlet chamber is secured to the risers 29 by screws 63 which pass through lugs 64 on each of the risers and are threaded into the walls of the chamber. Integral with the shell 59, extending downwardly therefrom, and having a flange 65 on its lower end is a hollow neck 66. Screws 67, which pass through the flange 65 and are threaded into the annulus 42, secure the secondary air chamber to the lower part of the carburetor. Fitting tightly within the neck 66 and secured thereto by the screws 68 is a bushing 69 having an opening therethrough in alignment with the opening in the strangle tube.

The upper and lower walls of the conduit 62 are provided with openings 70 and 71, respectively, concentric with the opening through the bushing 69. The edges of the material around the openings are shaped to provide seats for the valves 72 and 73, respectively, which are, as shown in the drawings, formed integrally from one piece of material.

In the top of the shell 59, there is provided an opening 74 which is closed by a cover 75 having therethrough an opening in alignment with the openings 70 and 71 and surrounded by a collar 76 which is lined with a bushing 77. A coiled spring 78 surrounds the portion of the collar 76 within the shell 59, bearing at its upper and lower ends, respectively, against the cover 75 and the double valve member 72—73, and urges the valves 72 and 73 toward their seats.

The double valve member 72—73 is rigidly mounted on a hollow shaft 79 which projects through the opening in the cover 74 and is slidable in the bushing 77. The opening in the upper end of the shaft 79 is made of smaller diameter than that in the lower end thereof, to provide a shoulder 80 for a purpose hereinafter specified.

The valve 45 is rigidly mounted on the lower end of the shaft 81 which extends slidably through the bushing 69, slidably through the bore in the hollow shaft and projects upwardly above the upper end of the latter. A shoulder 82 is provided on that portion of the shaft 81 which is within the hollow shaft 79, by reducing the upper end of the shaft 81, as indicated by the reference character 83. Surrounding the lower part of the reduced portion 83 of the shaft 81, located in the annular space between the shaft 79 and the shaft 81, and bearing at its opposite ends against the shoulders 80 and 82 is a coiled spring 84 which urges the valve 45 toward its seat.

On the upper end of the shaft 79 is threaded a collar 88 adapted to abut against the cover 75 to limit the downward movement of valves 72—73 and 45. It is obvious that the idle positions of the valves may be varied by merely screwing the collar 88 up or down on the shaft. The collar 88 is provided with an upwardly projecting sleeve against which another collar 87 which is threaded on the shaft 79 above the collar 88 is adapted to abut and thereby lock the collar 88 in any position to which it may be adjusted. On the upper end of the shaft 81 is threaded a collar 89 having a portion adapted to abut against the upper end of the shaft 79 to limit the downward movement of the valve 45 with respect to the valve 72—73 and which may be screwed up or down on the shaft 81 to vary the idle position of the valve 45 independently of that of the valve 72—73. A nut 89′ is threaded on the shaft 81 above the collar 89 to provide means whereby the collar may be locked in any position to which it may be adjusted.

The cover 74 carries on its upper surface two spaced, upwardly projecting arms 85 and 86. Between the arms 85 and 86 are positioned, in vertically spaced relationship, the bights of two yokes 90 and 91 which are pierced, respectively, by the pins 92 and 93, both of which are journalled in both of the arms 85 and 86. Relative rotation of the pin 92 and the yoke 90 and the pin 93 and the yoke 91 is prevented, respectively, by the pins 94 and 95. The arms of the yoke 90 are positioned on opposite sides of the shaft 79 and below the collar 89, and the arms of the yoke 91 are positioned on opposite sides of the shaft 79 and between the collars 87 and 88.

To the end of the pin 93 which projects outwardly beyond the arm 85, there is secured an operating arm 96 which is prevented from rotating with respect to the pin 93 by the cross pin 97. On the end of the pin 92 which projects beyond the arm 86 is pivotally mounted a second operating arm 98. A collar 99 which is held in place by a cross pin 100 prevents movement of the arm 98 longitudinally of the pin 92, and is provided with a lug 101 (Figures 1 and 5) against which the arm 98 is adapted to abut to limit the relative movement of the arm and the pin 92. Secured to or integral with the yoke 91 is an arm 102 through the free end of which passes a set screw 103 which is adapted to come into contact with the cover 75 when the yoke has been rocked through a predetermined angle to limit the upward movement of the shaft 79.

The valve 45 which constitutes a primary throttle and valve 72—73 which acts as a secondary or air throttle are held in the desired idle positions by the springs 84 and 78, and the spring 84, respectively, when the engine is not in operation. Under these conditions, the collar 89 on the reduced portion of the shaft 81 which carries the valve 45 engages the top of the shaft 79 which carries the valve 72—73. Operation of the arm 96 to lift the shaft 79 and open the valve 72—73 will obviously lift the shaft 81 at the same

time to open the primary mixture throttle. If the arm 98 is turned clockwise (as viewed in Figure 3), it will abut against the lug 101 and turn the pin 92 whereby the collar 89 and the shaft 81 will be lifted to open the primary throttle without opening the secondary air throttle unless the spring 84 is sufficiently compressed to overcome the pressure of the spring 78 which tends to hold the secondary air throttle closed. It will be clear from the above description that operation of the arm 98 will move the primary throttle independently of the secondary air throttle. Such movement of the primary throttle, while the secondary air throttle remains in a given position, will vary the amount of rich primary mixture entering the manifold while the amount of pure air entering the manifold remains constant. This independent movement of the primary throttle will, therefore, vary the proportions of fuel and air in the mixture delivered to the engine ports, an opening movement of the primary throttle enriching the mixture while a closing movement thereof will lean the mixture.

The pin 92 is left free to rotate independently of the arm 98 when the former is turned in a clockwise direction (as viewed in Figure 3) so that it will not be necessary to move the operating linkage, which will be provided for operating the arm 98 from the driver's seat, upon operation of the arm 96 to open both throttles simultaneously.

The apparatus shown in Figures 1—5 operates in the following manner: When it is desired to start the engine, the arm 98 is operated to lift the shaft 81 and open the primary throttle, which may be moved to partially open position without opening the secondary air throttle. When the engine is cranked with the parts in this position, air will enter the primary mixing chamber as indicated at A, picking up fuel from the nozzle 39 and forming therewith a rich mixture such as is desirable for starting. This rich mixture will be conveyed through the primary mixture conduits 48 to the manifold and thence to the intake ports of the engine without admixture of additional air, the secondary air throttle being closed at this time. After the engine has started and is operating at a comparatively slow speed the arm 96 is operated to open the secondary air throttle sufficiently to admit enough air to provide a mixture of such proportions as is suitable for operation of the engine at comparatively low speed and light load.

If it is desired to increase the speed of the engine or if the load increases and it is desired to maintain the same speed, as when the automobile ascends a hill, it is necessary to admit greater quantities of fuel mixture to the engine cylinders. This is accomplished by moving the arm 96 further in a clockwise direction (as viewed in Figure 3) which will lift the shaft 79 and open the secondary air throttle wider. As the secondary air throttle opens, the end of the shaft 79 will engage the collar 89 on the reduced portion of the shaft 81 and open the primary throttle simultaneously with the opening of the secondary air throttle, increasing the quantity of primary mixture admitted to the cylinders as well as the amount of secondary air.

There will be some movement of the secondary air throttle after the primary throttle has been opened to start the engine without an accompanying movement of the primary throttle due to the fact that the opening movement of the primary throttle for starting will compress the spring 84 and slightly separate the collar 89 from the end of shaft 79. The extent of this independent movement will depend upon the strength of the springs 78 and 84 and the original position of the primary throttle, which will be predetermined to give best starting operation. This independent movement will cease when the secondary air throttle has been opened sufficiently to bring the end of the shaft 79 into contact with the collar after which further opening of the secondary air throttle will cause simultaneous further opening of the primary throttle.

During simultaneous opening movement of the secondary air throttle and the primary throttle, the proportionate increase in flow of secondary air is greater than the increase in flow of primary mixture because of the difference in size of the secondary air throttle and the primary throttle and the difference in inclination of the seating portions of the valves and their cooperating seats. This results in a leaning of the mixture as the throttle opens and secures economy in fuel consumption.

Under certain conditions, it is desirable to enrich the mixture supplied to the cylinders over that normally supplied. This is accomplished by operating the arm 98 to lift the shaft 81 and open the primary throttle while the secondary air valve remains stationary. The primary throttle may be operated in this manner at any time it is desirable to provide a richer than normal mixture. When the arm 98 is released, the valve 45 is forced back to its normal position relative to the valve 72—73 by the spring 84.

The engine shown in Figures 6—9 is identical with that shown in Figures 1—5 and the same reference characters have been applied to it. The intake manifold 110 includes two forward conduits 111, each opening at its forward end into the front intake port in one of the cylinder blocks and at its rear end into the second intake port in the same block, and two rear conduits 112, each united with the corresponding conduit 111 by a web 113 and each opening at its forward end into the third intake port in one of the blocks and

at its rear end into the fourth intake port in the same block. Screws, such as 114, extend through flanges on each of the conduits and through the web 113 and into the corresponding block and secure the manifold tightly to the blocks. Each of the risers 115 opens at one end into the upper side of one of the conduits 111 and at its other end into the upper side of the corresponding conduit 112. A third conduit 116 opens at one end into the upper side of one of the risers 115 and at its opposite end into the upper side of the opposite riser 115 and unites the opposite conduits 111, 112 and the opposite risers 115 into an integral structure. On its bottom side and substantially midway between its ends, the conduit 116 is provided with an opening 117 for a purpose hereinafter specified.

In the space between the two cylinder blocks is positioned a carburetor including a float bowl 118 which is essentially identical with that of the carburetor shown in Figures 1—5 and which for the purposes of this case will require no further description. Within the primary air passage 118′, which is open at its lower end to the atmosphere, is a fuel nozzle 119 which is similar to that shown in Figures 1—5 and similarly connected to the float bowl.

Seated on the top of the float bowl with its hollow portion coaxial and communicating with the passage surrounded by the float bowl is a cylindrical member 120 which forms the primary mixing chamber and which is closed at its upper end and is provided with upper and lower outwardly extending circumferential flanges 121 and 122. The member 120 is secured to the float bowl by screws 123 passing through the latter and threaded into the former. A strangle tube 124 is clamped between the member 120 and the top of the float bowl with its restricted portion projecting into the passage surrounded by the float bowl and surrounding, but spaced from, the upper end of the noozle 119 and with its enlarged portion projecting into and merging with the inner wall of the member 120.

The outer side of the side wall of the member 120 is shaped to provide four outwardly projecting equi-circumferentially spaced projections 125 each of which is provided with a flange 126 on its outer end. Extending through each of these projections from its outer end into the primary mixing chamber is a bore 127. Through each of these bores and opening into the primary mixing chamber extends a pipe 128 which is provided with a flange, or collar, 129 bearing against the outer side of the flange 125. Screws 130 which extend through the flanges, or collars, 129 and are threaded into the flanges 125 secure the pipe to the member 120. Two nozzles 131, which are identical with those bearing the reference character 50 in Figures 1—5 are threaded into each of the conduits 111 and 112, each nozzle opening into the conduit as close as possible to one of the intake ports. The members 132 are identical with the members 53 in Figures 1—5 and one is connected to each nozzle 131 in the same manner as the members 53 are connected to the nozzles 50. Both of the members 132 of the pair on each conduit open into a pipe 133. One of the pipes 128 opens into each of the pipes 133 at a point substantially midway between its ends.

The secondary air inlet chamber 134 consists of a substantially cylindrical main body portion 135, which is entirely out of communication with primary mixture chamber, being closed at its lower end, as shown in Figures 7 and 8, and is provided at one side with an integral elongated hollow extension 136 which opens into the main body portion, as shown in Figure 8. The chamber 134 is secured at its lower end on the top of the cylindrical member 120 by screws, such as 137, which pass through the flanges 121 and are threaded into the bottom of the secondary air chamber. The main body portion is open at its upper end and is secured to the conduit 116, with its open end communicating with the opening 117 therein, by the bolts 140 which pass through flanges 138 and 139 on the conduit and upper end of the main body portion, respectively, and are secured in place by the nuts 141. In the lower side of the extension 136, there is provided an air inlet opening 142, which is controlled by the pivoted and counterweighted valve 143, which is, in turn, controlled by the spring 144. A set screw 145, acting through the pivoted lever 146, is provided for the regulation of the tension of the spring 144. To prevent rattling of the parts when spring 144 is uncompressed, or only slightly compressed, springs such as 147 are provided, which hold the lever 146 tightly against the set screw 145. An arm 172 is provided for manual operation of the valve 143.

An ordinary butterfly valve 148 which is located in the lower end of the primary mixture chamber is adapted to control the entrance of air and fuel into the chamber. The valve 148 is mounted on a rod 149 which is journaled in bearings 150 integral with the side walls of the chamber. A second butterfly valve 151, which is located in the upper end of the secondary air chamber, is adapted to control the entrance of secondary air into the manifold. The valve 151 is mounted on a rod 152 which is journaled in bearings 153 integral with the side walls of the chamber. Each of the rods 149 and 152 extend outwardly at both ends beyond their journals. To one end of the rod 152 is rigidly secured an operating arm 154, in which is threaded a set screw 155 which is adapted to abut against a projection 156 secured to the secondary air inlet chamber to limit the closing move-

ment of the valve, and on the corresponding end of the rod 149 is journaled the operating arm 157. Longitudinal displacement of the arm 157 on the rod 149 is prevented by the collar 158, which is prevented from rotating with respect to the rod by the pin 159. A lug 160 which is integral with the collar 158 extends into abutting relation with one side of the arm 157 to limit relative movement of the arm and the rod 149.

To the end of the rod 152 opposite that carrying the arm 154 is rigidly secured a second arm 161 and to the corresponding end of the rod 149 is pivotally secured an arm 162 which carries a lug 163 in which is threaded a set screw 164 which is adapted to abut against the arm 166 which is rigidly mounted on the same rod to limit relative movement of the two arms. Longitudinal displacement of the arm 162 on the rod 149 is prevented by the collar 167, which is non-rotatably mounted on the rod and carries an arm 168. The two valves are operatively connected by a rod 169 which is pivotally connected at one end to the arm 161 and at the other end to the arm 162. A tension spring 170 is connected at its opposite ends to the arms 161 and 168.

The modified form of apparatus shown in Figures 6—9 operates in substantially the same manner as that shown in Figures 1—5. In order to start the engine, the primary throttle is opened by operation of the arm 157, the secondary air throttle 151 remaining closed, since the arm 162, through which and the rod 169 and the arm 161 the primary throttle and the secondary air throttle are operatively connected, is not moved, the arm 166 being moved away from instead of toward the set screw 164 carried by the lug 163. The engine is then cranked and air enters the primary mixing chamber, as indicated at B, picking up fuel from the nozzle 119 and forming therewith the rich primary mixture, which is desirable for easy starting, which is conveyed through the conduits 128 and 133 and the manifold to the engine intake ports without admixture of additional air. After starting the secondary air throttle is opened by means of its operating arm 154, just as in the case of the form of the apparatus shown in Figures 1—5.

To supply the engine with larger quantities of fuel mixtures for increased speed or load, the arm 154 is operated to open the secondary air throttle. When the secondary air throttle has been opened sufficiently to cause the arm 162 to rotate through an angle equal to that through which the rod 149 was turned to open the primary throttle for starting, the set screw 164 abuts against the arm 166 thereafter causing simultaneous opening of the secondary air throttle and the primary throttle. Owing to the difference in size of the two throttles, the air increases in greater proportion than the fuel, as the throttles are opened simultaneously, leaning the mixture, as is desirable in the interest of fuel economy.

To enrich the mixture, when this is desirable, the arm 157 may be operated to open the primary throttle independently of the secondary air throttle, the spring 170 acting to return the primary throttle to its original position with respect to the secondary air throttle after the operative force applied to the arm 157 is removed. The mixture may also be enriched whenever desired by holding the valve 143 closed by means of the arm 172. In fact, in starting the valve 143 may be held closed in the manner set forth and the arm 154 operated to open both the secondary air throttle 151 and the primary throttle. Since the entrance for secondary is held closed under these conditions, no air is admitted to the manifold to dilute the primary mixture and the mixture reaching the engine ports is the same as when starting the engine in the manner previously described.

The rod 149 is left free to rotate independently of the arm 157 when the former is turned in a counterclockwise direction (as viewed in Figure 8) so that it will not be necessary to move the operating linkage, which will be provided for operating the arm 157 from the driver's seat, upon operation of the arm 154 to open both throttles simultaneously.

The secondary air, it will be noted, has to pass two valves (143 and 151) before entering the manifold. The position of the valve 151 is adjustable by the operator to control the speed of the engine whereas under ordinary running conditions the position of the valve 143 is controlled by the velocity of air passing therethrough or the suction of the engine and, for this reason, the use of it in series with the valve 151 gives a more accurate metering of the air than is possible by use of the valve 151 alone.

In both of the forms of the apparatus heretofore described, there is a flow of primary mixture through all of the nozzles at all times when the engine is running, varying in quantity as the vacuum in the manifold is varied. When the engine intake valve adjacent any given nozzle is closed, this nozzle still delivers primary mixture into the manifold due to the vacuum created by those cylinders whose intake valves are open at the moment. This condition, it will be obvious, eliminates the necessity of supplying additional fuel when it is desired to accelerate the speed of the engine.

In Figure 10, the reference characters 180 and 181 indicate the opposed cylinder blocks of a V-8 engine. Between the blocks is positioned a carburetor 182, which may be similar to either of those heretofore described. A manifold 183 leads from the sec-

ondary air chamber of the carburetor and has a separate branch opening into each of the intake ports in each block. In this modification, there are but two pipes, 184 and 185, opening into the primary mixture chamber of the carburetor, each of which opens into a primary mixture manifold 186. One of these manifolds is positioned adjacent each block and each is provided with four nozzles 187 which are similar to the nozzles 50 in Figures 1—5. Each of the nozzles on the manifold 186 adjacent the block 180 opens into the manifold 183 adjacent one of the intake ports in that block and each of the nozzles on the opposite primary mixture manifold opens into the manifold 183 adjacent one of the intake ports on the block 181. The operation of the apparatus shown in Figure 10 will be obvious from what has previously been said.

It will be understood that any of the arrangements of primary mixture pipes disclosed herein may be used with either of the carburetors described and that either of the carburetors disclosed herein may be applied to practically any type of internal combustion engine by modifications which will be obvious to those skilled in the art.

Though I have shown and described specific embodiments of my invention, this has not been done with the intention of limiting my invention thereto. It will be understood, of course, that the scope of my invention is limited only by the appended claims.

I claim:

1. A charge forming device for an internal combustion engine having a plurality of cylinders and a separate intake port for each cylinder, including a primary mixing chamber and a secondary air chamber, a manifold opening into the secondary air chamber and including a separate branch opening into each of the intake ports, a plurality of conduits, in number equal to the number of cylinders of the engine, all opening at one end into the primary mixing chamber and each opening at its opposite end into the manifold one adjacent each intake port.

2. In a charge forming device for an internal combustion engine, a primary mixing chamber, a strangle tube through which fuel and air pass into the chamber, a secondary air conduit having an opening in one of its walls through which air may pass into the interior thereof, a valve adapted to seat in said strangle tube, a valve adapted to seat on the wall surrounding the edges of said opening, and means whereby said valves may be operated to regulate the flow of fuel and air to the engine.

3. The invention claimed in claim 2 in which said means includes a hollow shaft secured to one of said valves a shaft secured to the other of said valves, said last mentioned shaft extending slidably through the bore in the first mentioned shaft, means for moving said shafts unitarily, and means for moving one of said shafts independently of the other.

4. In carbureting apparatus, a primary mixing chamber, a secondary air chamber, a valve in each of the chambers, means whereby the valves may be operated as a unit or one of the valves operated independently of the other including, operating mechanism, an element by means of which the operating mechanism may be operated so as to operate the valves as a unit, a lost motion connection in the operating mechanism, and a second element by means of which one of the valves may be operated independently of the other.

5. A charge forming device for an internal combustion engine having a plurality of cylinders and a separate intake port for each cylinder, including a primary mixing chamber and a secondary air chamber, a manifold opening into the secondary air chamber and including a separate branch opening into each of the intake ports, a conduit opening at one end into the manifold adjacent one intake port and at its opposite end into the manifold adjacent a second intake port, and a conduit opening at one end into the primary mixing chamber and at its opposite end into the first mentioned conduit intermediate the ends thereof.

6. A charge forming device for an internal combustion engine having four cylinders and a separate intake port for each cylinder, including a primary mixing chamber and a secondary air chamber, a manifold opening into the secondary air chamber and including a separate branch opening into each of the intake ports, a pair of conduits each opening at one end into the manifold adjacent one intake port and at its other end into the manifold adjacent the adjacent intake port, and a pair of conduits each opening at one end into one of the first mentioned conduits and both opening at their opposite ends into the primary mixing chamber.

7. A charge forming device for an internal combustion engine having in one block a plurality of cylinders in number greater than two and a separate intake port for each cylinder, including a primary mixing chamber and a secondary air chamber, a manifold opening into the secondary air chamber and including a separate branch opening into each of the intake ports, a conduit adjacent said manifold and engine ports and opening at one end into the manifold adjacent the front intake port in the block, at its opposite end into the manifold adjacent the rear intake port in the block and intermediate its ends into the manifold adjacent the intermediate intake port or ports, and a second conduit opening at one end into the primary mixing chamber and at

its opposite end into the first mentioned conduit.

8. In a charge forming device for an internal combustion engine, a primary mixing chamber, a secondary air chamber, a valve for controlling the entrance of fuel and air into the primary mixing chamber, a valve for controlling the entrance of air into the secondary air chamber, a valve within said secondary air chamber in series with and cooperating with said second mentioned valve, and means for operating said valves.

9. In a charge forming device for an internal combustion engine, a primary mixing chamber, a secondary air chamber, a valve for controlling the entrance of fuel and air into the primary mixing chamber, a pivoted rod on which said valve is mounted, an operating arm secured to one end of the rod, a valve for controlling the secondary air, a pivoted rod on which said valve is mounted, an operating arm secured to the corresponding end of the second rod, a lever fixed to the opposite end of each of said rods, a second lever pivotally mounted on the last mentioned end of one of said rods, means to limit the pivotal movement of said last mentioned lever with respect to said rod, a link pivotally connected to said pivoted lever and to the fixed lever on the other rod, and resilient means connecting the two fixed levers.

10. In apparatus of the class described, primary and secondary throttle valves, means for opening the primary valve, and means associated with the valves and so arranged that the secondary valve will begin to open only after the primary valve has been opened to a predetermined extent.

11. In apparatus of the class described, a primary mixing chamber, a secondary air chamber, means for conveying primary mixture to points adjacent the engine cylinders, separate means for conveying secondary air to points adjacent the engine cylinders, a valve for controlling the flow of primary mixture, a valve for controlling the flow of secondary air, means for opening the primary valve, and means associated with the valves and so arranged that the secondary valve will begin to open only after the primary valve has been opened to a predetermined extent.

12. The invention claimed in claim 10 plus a fixed element and in which the last-mentioned means includes a resilient connection between the valves and a resilient connection between the secondary valve and the fixed element.

13. The invention claimed in claim 10 in which the last-mentioned means includes a lost motion connection between the valves and a resilient connection between the valves.

14. In apparatus of the class described, a primary mixing chamber, a secondary air chamber, means for conducting primary mixture to points adjacent the engine cylinders, separate means for conducting secondary air to points adjacent the engine cylinders, means for controlling the flow of primary mixture, means for controlling the flow of secondary air, and means associated with the two last-mentioned means and so arranged that the second-mentioned means will begin to operate only after the first-mentioned means has been moved a predetermined amount.

15. In apparatus of the class described, a primary mixing chamber, a secondary air chamber, independent entrances for air into the primary and secondary chambers, valves for controlling the flow through the primary and secondary chambers, and means interconnecting said valves so that they may be operated unitarily.

16. The invention claimed in claim 10 in which there is provided means whereby the secondary air valve may be operated independently of the primary valve.

17. The invention claimed in claim 15 in which there is provided means whereby the secondary valve may be operated independently of the primary valve.

18. In apparatus of the class described, a primary mixing chamber, a secondary air chamber, means for conveying primary mixture to points adjacent the engine cylinders, means for conveying secondary air to points adjacent the engine cylinders, a valve in the primary mixing chamber, a valve in the secondary air chamber, operating mechanism for the valves, an element by means of which the operating mechanism may be operated so as to operate the valves as a unit, a lost motion connection in the operating mechanism, and a second element by means of which one of the valves may be operated independently of the other.

19. In a charge forming device for a multi-cylinder internal combustion engine, a primary mixing chamber, an orifice through which fuel is adapted to be discharged into the primary mixing chamber, a secondary air manifold having branches opening into the intake ports of the engine, conduits communicating with the primary mixing chamber adapted to conduct primary mixture therefrom to points adjacent the intake ports before it becomes mixed with secondary air, and a valve posterior to the fuel orifice for controlling the entrance of fuel and air into the primary mixing chamber.

In testimony whereof I affix my signature.

CHARLES E. WILLIAMS.