March 30, 1937. W. R. ANGELL, JR., ET AL 2,075,330

ENGINE

Filed May 12, 1933 3 Sheets-Sheet 1

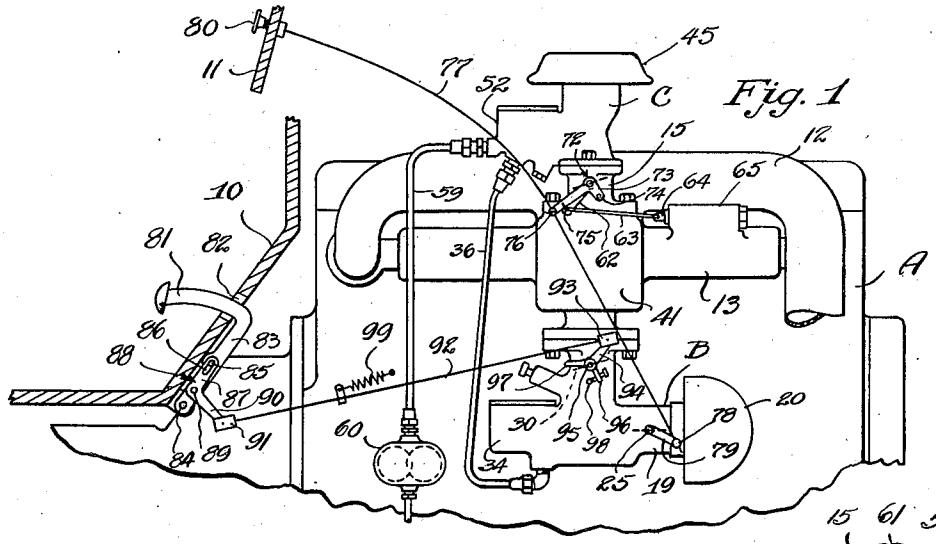

Fig. 1

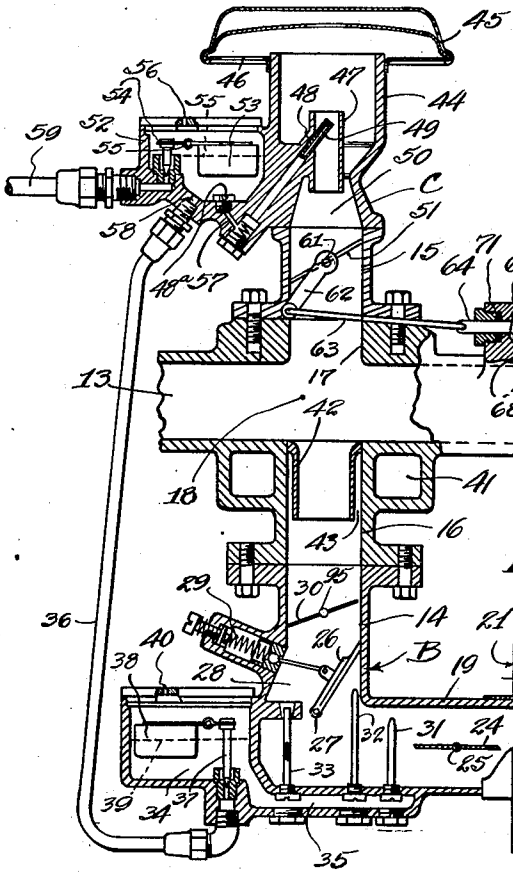

Fig. 2

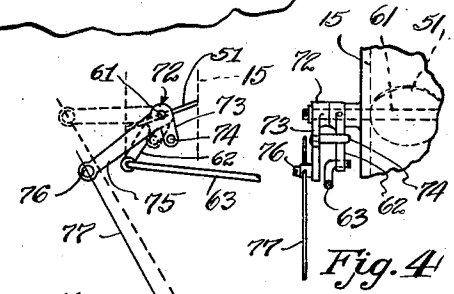

Fig. 4

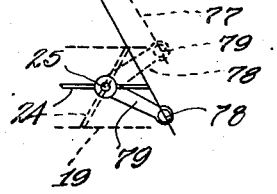

Fig. 3

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ENGINE

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Fig. 6

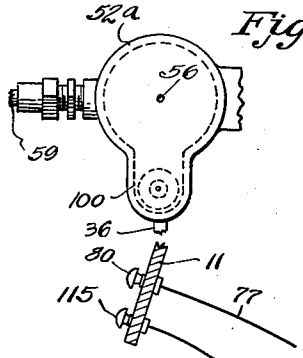


Fig. 5

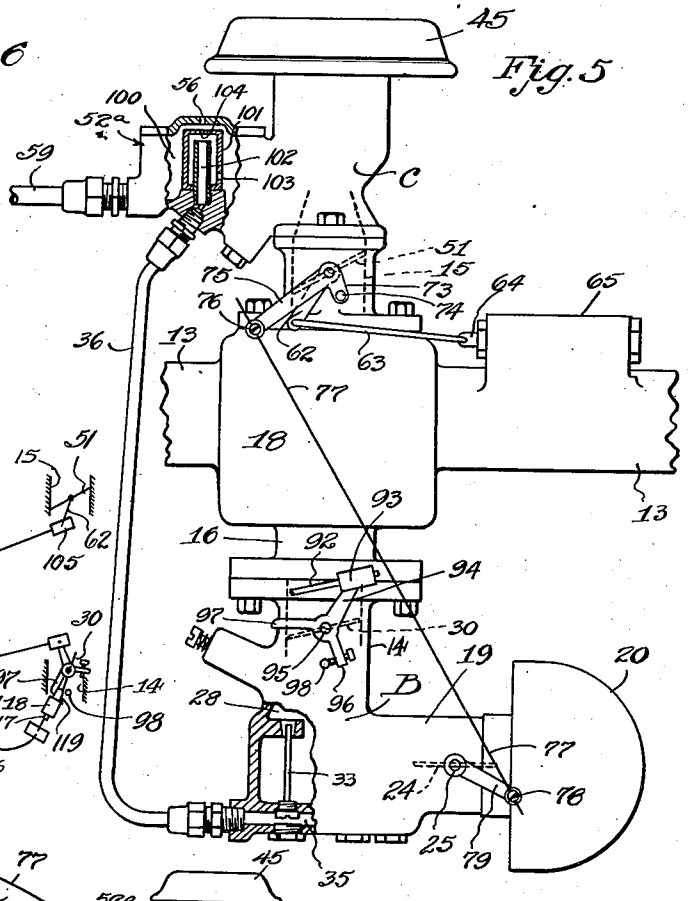


Fig. 8

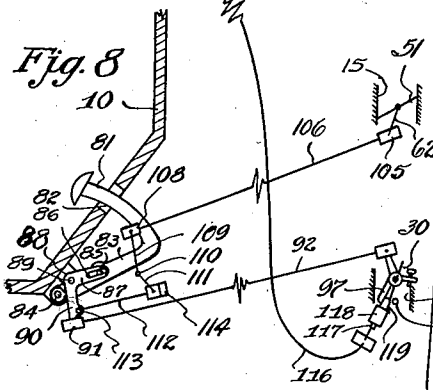
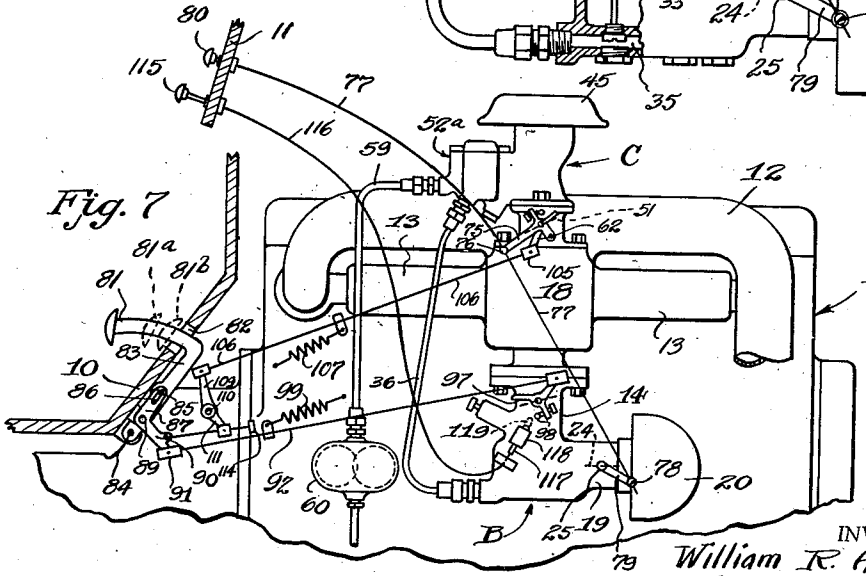


Fig. 7



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ENGINE

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Fig. 12

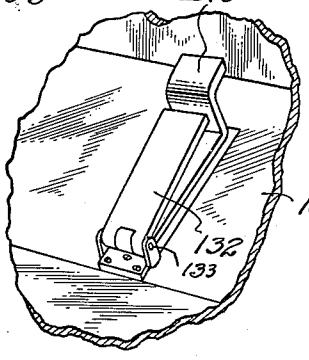


Fig. 10

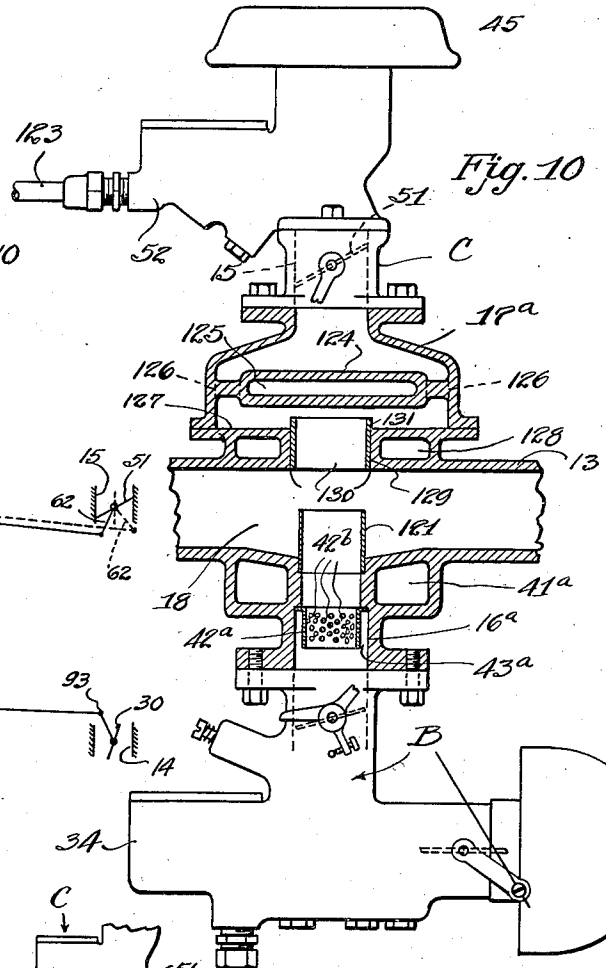


Fig. 11

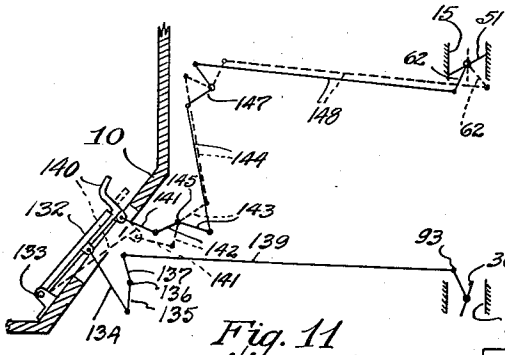
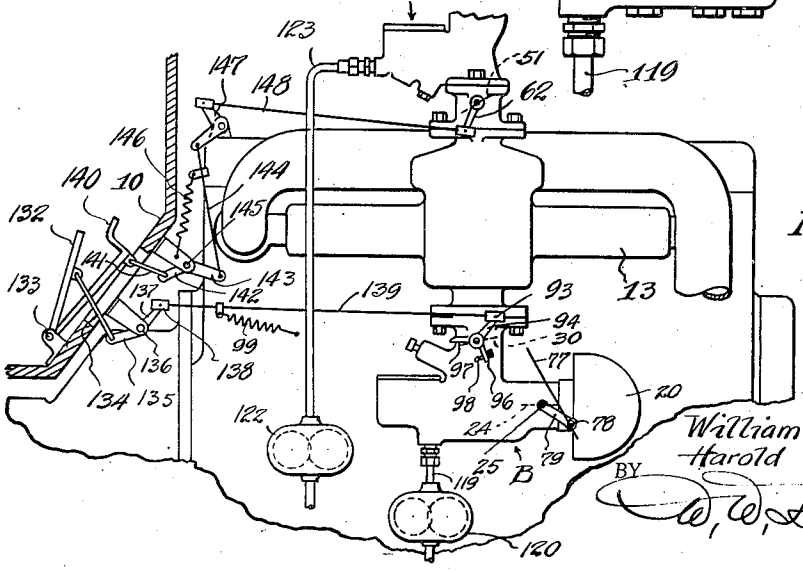


Fig. 9



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Patented Mar. 30, 1937 2,075,330

UNITED STATES PATENT OFFICE

2,075,330

ENGINE

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Application May 12, 1933, Serial No. 670,626

11 Claims. (Cl. 123—127)

This invention relates to internal combustion engines and refers more particularly to improved methods and apparatus for forming a combustible fuel mixture and supplying same to the engine.

Our invention is especially adapted for use in forming and supplying fuel mixture to an internal combustion engine of the type adapted for use in an automobile, bus, truck or the like, although our invention is by no means limited to such uses since our improvements are equally well adapted to engines used for propelling aircraft, marine craft, and other fields of application, particularly where the engine is required to operate over a varying power range.

Heretofore, efforts have been made to supply the engine with a fuel mixture, ordinarily air and a hydrocarbon such as gasoline, wherein the engine will be capable of delivering a relatively high power and at the same time provide good torque characteristics and low fuel consumption over the throttle valve or power range. It has been found however, that, with carburetor devices known heretofore, these desirable qualities cannot be obtained altogether in any engine and it is customary in engine design and operation to provide fuel mixture forming apparatus which will effect a compromise between power and economy. In other words, it has been deemed necessary to limit the power output of an engine in order to provide a reasonable fuel consumption, or where high power output is most important, the fuel consumption is relatively high.

It is an object of our invention to provide improved methods and apparatus for forming and supplying the engine with a combustible fuel mixture whereby we are enabled to operate the engine with improved fuel economy over the throttle range, without sacrificing the power output of the engine. By reason of our invention we are enabled to materially increase the engine power output and fuel economy in comparison with corresponding characteristics experienced in engines which are now in general use.

A further object of our invention is to provide improved means for supplying the engine with its combustible charge whereby the efficiency and general over-all performance of the engine is increased and bettered.

In carrying out our invention in one of its embodiments, we have provided a plurality of fuel mixing devices or carburetors, preferably two in number, these carburetors being arranged to deliver their respective charges to a common manifold distributing chamber from which the fuel mixture is conducted by a suitable intake manifold to the various cylinders of the engine. This chamber is preferably remote from the mixing chambers of the carburetors. In the more limited aspects of our invention, these carburetors are preferably arranged so that one delivers its charge upwardly to the distributing chamber and the other delivers its charge downwardly thereto. Thus we have preferably provided an updraft carburetor and a downdraft carburetor, each having a throttle valve for regulating the quantity of fuel mixture delivered to the distributing chamber. While we do not limit our invention in its broader aspects to any particular arrangement of carburetors or types of carburetors, we prefer to employ an air valve type of carburetor below the distributing chamber and an open venturi or plain tube type carburetor above the distributing chamber although, if desired, both carburetors may be of the plain tube or any desired type. With such an arrangement we have provided for controlling the throttle valves for the carburetors so that one of them, preferably the air valve updraft carburetor, is adapted to normally function by itself independently of the other carburetor in supplying the fuel mixture to the engine over the lower power range whereby to provide good economy of operation over the engine power range which is customarily used to the greatest extent where the engine is operating an automobile for example. As the power range increases beyond any desired predetermined value, the second or downdraft carburetor is employed to supplement the delivery of the first carburetor, and in this way, we are enabled to greatly increase the power range and output of the engine over that which would otherwise ordinarily be obtainable through the use of a single carburetor.

For convenience of reference throughout our specification and claims we have, in certain instances, referred to the carburetors as primary and secondary. The primary carburetor supplies fuel mixture over the lower range of engine power and the secondary carburetor supplies fuel mixture over the higher range of engine power output. The throttle valves controlling the carburetors

may be correlated for operation in either of several different manners. Thus, an accelerator pedal or other manually operable control device may be employed for the primary carburetor and the secondary carburetor may be controlled by and in accordance with the conditions of pressure in the intake manifold so as to automatically respond at a predetermined pressure difference to supplement the delivery of the primary carburetor.

As an alternative of the foregoing arrangement, we contemplate in certain instances, the provision of a single accelerator pedal or other manual control connected to progressively open and close the carburetors. In this instance, we contemplate the provision of some means which will advise the operator of the conditions under which the carburetors are functioning. In other words, the accelerator pedal may be resisted by a relatively light spring over the range of movement which will open the throttle valve of the primary carburetor, additional movement of the accelerator pedal being opposed by a relatively heavy spring, this additional movement of the accelerator pedal being arranged to open the throttle valve of the second carburetor. We have also provided a manual control whereby the secondary carburetor may be locked out of control or else positioned so that the carburetors may be selectively operated by the accelerator pedal. In the foregoing manner the operator will be aware, without any great inconvenience, of the operation of the primary and secondary carburetors, so that if he desires to operate the motor vehicle under conditions of maximum economy, he can readily move the accelerator pedal only through the range of movement which actuates the throttle valve of the primary carburetor. At the same time, he is enabled to immediately supplement the supply of fuel mixture from the primary carburetor, by further depressing the accelerator pedal, this being desirable where extra power of the engine is desired for purposes of more rapid acceleration, hill climbing, fast speed, etc.

We have also disclosed a still further arrangement for controlling the throttle valves of the primary and secondary carburetors. Thus, an accelerator pedal or other manually operable control device may be employed for the primary carburetor, and a second accelerator pedal or the like may be employed for the secondary carburetor, these pedals being preferably arranged so that the pedal for the primary carburetor may be actuated either independently of the pedal for the secondary carburetor, or else, progressively operated. Where the accelerator pedals are operated progressively, the foot of the operator will pick up the pedal for the secondary carburetor after the pedal of the primary carburetor has been actuated to a predetermined extent, both pedals being thereafter operated together.

Bearing in mind that one of the primary objects of our invention resides in the provision of improved economy operation, we prefer, in order to realize the greatest economy, to positively control the throttle valve of the secondary carburetor so that it does not open to supply fuel mixture to the engine over the previously established desired range of low load operation. This latter range is thus preferably, in such instance, supported wholly by the primary carburetor. However, where maximum economy is less essential and it is desired to somewhat compromise economy for maximum improved performance, then the secondary carburetor may supplement the delivery of the primary carburetor throughout the whole power range as, for example, at times when sudden demands for engine power (as in accelerating) are made, or for the high power range. This operation involving the said economy compromise, nevertheless provides a greatly improved over-all economy of engine operation with respect to conventional devices prior to our invention. Our invention must not be confused with conventional carbureting practice referred to hereinbefore.

One contributing factor of this improved economy resides in the distribution of the fuel mixture from the primary and secondary carburetors wherein the kinetic energy of the opposing streams is utilized to increase the pressure in the distributing chamber of the intake manifold, thereby increasing the ramming effect in the manifold with resulting increase in volumetric efficiency.

Where the manifold pressure control, referred to hereinbefore, is used, it will be noted that the secondary carburetor will be automatically responsive to load demands, as for example, when the motor vehicle encounters a change of gradient or road load variation with fixed setting of the throttle of the primary carburetor.

A still further object of our invention resides in the provision of a multi-carburetor fuel mixture supply system, the fuel being supplied to the carburetors in an improved manner, preferably consisting in a plurality of float controlled supply chambers. More specifically, the float chamber associated with the primary carburetor is preferably supplied by gravity from the float chamber associated with the secondary carburetor, a fuel pump or other suitable device well known in the art being utilized to pump the fuel from the usual fuel tank or reservoir to the last named float chamber.

While our invention, in the specific embodiment disclosed for purposes of illustration, contemplates the employment of a pair of carburetors, we desire to point out that our arrangement is relatively simple and inexpensive.

The fuel mixture from the primary carburetor is preferably supplied with a relatively large amount of heat, this being accomplished by utilization of the exhaust gases surrounding the riser of the primary carburetor as will be readily understood, the fuel mixture from the secondary carburetor (except where a heavy hydrocarbon is used) preferably being supplied "cold" or without the application of heat, such an arrangement being very beneficial in providing for maximum economy for the primary carburetor over the lower range of engine power output and also for maximum power and economy when the secondary carburetor is functioning in conjunction with the primary carburetor over the higher range of engine power output.

We do not limit our invention to any particular range of activity over which the primary carburetor is adapted to function, or over which the secondary carburetor is adapted to function in conjunction with the primary carburetor or by itself. As an example however of the great benefits to be realized by our invention, we desire to point out that the primary carburetor may be utilized to normally supply the engine with its requirements of fuel mixture for speeds up to 50 or 60 miles per hour of vehicle travel. The secondary carburetor being then utilized for vehicle speeds in excess of 60 miles per hour. It will be understood that at such times when the

load of the engine is such that the fuel mixture requirements exceed normal conditions of straight running of the vehicle, the secondary carburetor will preferably function to supplement the delivery of the fuel mixture to the engine regardless of the actual speed of travel of the vehicle.

For very favorable conditions of economy and motor venicle performance, the secondary carburetor may be arranged to become effective after approximately 90% of the total horse power output of the engine has been reached, the total output being that obtainable through the combined delivery of the two carburetors.

A further object of our invention resides in the provision of means for efficiently conducting the fuel mixture streams from the primary and secondary carburetors to the manifold distributing chamber, whereby these fuel mixture streams will be efficiently mixed for equal distribution to the various engine cylinders.

We have also provided, as a modification, improved means preferably in the form of a riser outlet member adapted for association preferably with carburetors having stratified fuel discharge characteristics whereby to act on the relatively wet or stratified particles which tend to pass along the riser walls, these particles being directed in an improved manner with the main body portion of the fuel mixture passing through the riser. By reason of this feature of our invention, the localized wet fuel particles are collected and distributed as a substantially uniform film through the riser outlet member.

Our invention may be used to advantage with hydrocarbons of different specific gravity. Thus, the primary carburetor may be arranged to operate on gasoline and the secondary carburetor may be supplied with a relatively heavy hydrocarbon such as kerosene, fuel oil, etc. This arrangement will be found to be of particular benefit for engines adapted to propel busses, trucks, and the like, where good acceleration for city driving is desired, the high power range being supplemented by the activity of the secondary carburetor using the relatively inexpensive heavy hydrocarbon. With such an arrangement the fuel mixture supplied by the secondary carburetor is preferably subjected to heat prior to passage to the manifold distributing chamber, whereby the heavier ends of the wet fuel may be vaporized. With this embodiment of our invention, we have also provided improved means for bringing the fuel mixture streams from the primary and secondary carburetors into close association at the manifold distributing chamber whereby to efficiently intermingle the two hydrocarbon mixtures for uniform distribution to the respective engine cylinders.

Further objects and advantages of our invention will be apparent as this specification progresses, reference being had to the accompanying drawings illustrating preferred forms thereof, and in which:

Fig. 1 is a side elevation view of an internal combustion engine equipped with our improved charge-forming apparatus, the primary carburetor being actuated by an accelerator pedal and the secondary carburetor being responsive to pressure variation in the intake manifold.

Fig. 2 is a sectional elevation view through the primary and secondary carburetors of Fig. 1,

Fig. 3 is a diagrammatic elevation view of our choke controlling device for the throttle valves of the primary and secondary carburetors of Fig. 1,

Fig. 4 is a fragmentary side elevation view of the throttle valve control mechanism for the secondary carburetor of Fig. 1,

Fig. 5 is an elevation view partly in cross-section of our primary and secondary carburetors, the parts in section illustrating a modified form of supplying fuel mixture to these carburetors by employing only one float chamber,

Fig. 6 is a detail plan view of the float chamber associated with the secondary carburetor of Fig. 5,

Fig. 7 is a view corresponding to Fig. 1 illustrating the single float chamber arrangement of Fig. 5 and further illustrating a modified control for the carburetor throttle valves wherein a single accelerator pedal is adapted to progressively operate the throttle valves of the primary and secondary carburetors,

Fig. 8 is a diagrammatic view of the throttle valve control mechanism of Fig. 7, the primary throttle valve being open and the secondary throttle valve being closed,

Fig. 9 is a view corresponding to Fig. 1 but illustrating primary and secondary carburetors arranged for supplying hydrocarbons of different specific gravity, the throttle valves for the carburetors being also modified as to their control whereby separate accelerator pedals are arranged to selectively or progressively operate the throttle valves.

Fig. 10 is an elevation view partly in cross-section of the primary and secondary carburetors of Fig. 9, the parts associated with the manifold distributing chamber being shown in cross-section,

Fig. 11 is a diagrammatic elevation view of the control mechanism for the throttle valves shown in Fig. 9, the primary throttle valve being open and the secondary throttle valve being closed, and

Fig. 12 is a detail perspective view of the accelerator pedals for the controls of the throttle valves illustrated in Figs. 9 and 11.

Referring to the drawings, reference character A represents a typical internal combustion engine of well known construction and operation, this engine being shown for purposes of illustration as associated with a motor vehicle having the usual toe-board 10 and dash 11. Engine A has an exhaust manifold 12 and an intake manifold 13, the latter being adapted to conduct fuel mixture to the various intake ports of the engine cylinders (not shown) in the well-known manner.

The intake manifold 13 has associated therewith a primary carburetor B and a secondary carburetor C, the primary carburetor being illustrated as the air valve updraft type and the secondary carburetor C being illustrated as the plain tube downdraft type. Carburetor B has a riser 14 associated therewith and carburetor C has a riser 15 associated therewith, these risers being referred to as primary and secondary risers respectively for convenience of reference. The manifold 13 also has the primary and secondary risers 16 and 17 respectively aligned with the primary and secondary carburetor risers 14 and 15, the primary and secondary manifold risers 16 and 17 respectively being preferably coaxial so as to direct their respective fuel mixture charges from opposite directions to the manifold distributing chamber 18 whence the fuel mixture is conducted substantially at right angles to the flow in the manifold risers and in opposite directions laterally of the engine for distribution to the engine cylinders.

The primary carburetor B has an air intake conduit 19 to which may be attached an air cleaner 20, the latter admitting air at 21 for passage through the cleaning material 22 whence the air passes to chamber 23 and the intake conduit 19. The conduit 19 has a choke valve 24 movable about a pivot 25, the control of the choke valve being referred to hereinafter in greater detail.

Carburetor B has an air valve 26 located for movement about a pivot 27, the air valve being located in the mixing chamber 28 of the carburetor. The air valve 26 will be recognized by those skilled in this art as being of the type which is adapted to open against the adjustable compression of spring 29 in accordance with the demands of the engine as the primary throttle valve 30 is opened. Fuel is supplied to the mixing chamber 28 for mixture with the air introduced through the conduit 19, by reason of a series of jets 31, 32, and 33, these jets conducting a liquid hydrocarbon fuel such as gasoline through their tubular central portions, the fuel being supplied to the jets from a float chamber 34 and the communicating fuel supply passage or chamber 35.

The float chamber 34 is supplied with fuel by a conduit 36, the fuel inlet to the float chamber being controlled by a valve 37 and float 38 whereby to maintain the fuel level indicated at 39. The float chamber 34 is vented to the atmosphere at 40.

The manifold riser 16 is preferably heated by a jacket 41 adapted to receive a portion of the exhaust gases conducted from the engine by exhaust manifold 12 in accordance with well known practice for applying heat to a fuel mixture. One feature of our invention which is quite independent of use in connection with our fuel charge-forming apparatus as a whole, consists in the provision of a riser outlet member 42 preferably located adjacent the manifold distributing chamber 18 and extending downwardly within the primary riser 16 so as to provide an annular pocket 43 bounded by the walls of the riser. If desired, a riser outlet of this general nature may also be used in connection with the down-draft riser, hereinafter referred to.

Referring now to the secondary carburetor C, it will be noted that this carburetor has an air conduit 44 to which may be attached a power roar silencer 45 adapted to receive air at 46 for passage to the conduit 44. This carburetor may be of the plain tube type wherein the air flowing through conduit 44 is adapted to pass through a tube 47, the latter having associated therewith a fuel supply nozzle 48 having a fuel outlet 49, the fuel mixture passing from the carburetor mixing chamber 50 through the secondary risers 15 and 17 to the manifold distributing chamber 18. The secondary carburetor riser 15 has associated therewith a secondary throttle valve 51, the operation of which will be hereinafter described.

Liquid fuel such as gasoline is supplied to the fuel nozzle 48 from a secondary float chamber 52, the supply being controlled by the usual metering jet 48a, the float 53 and inlet valve 54 cooperating as will be readily understood to maintain a fuel level indicated at 55. The float chamber 52 is preferably vented to the atmosphere at 56.

This float chamber has an outlet 57 from jet 48a for supplying fuel therefrom to the nozzle 48, the float chamber having a second outlet 58 for conducting fuel to conduit 36 whereby to supply the primary float chamber 34 with the required amount of fuel for meeting the demand of the primary carburetor B. Fuel is supplied to the secondary float chamber 52 by reason of a conduit 59 which conducts the fuel from a suitable reservoir such as the usual storage tank (not shown), the fuel being pumped by a suitable pumping device diagrammatically illustrated at 60 in Fig. 1.

Describing now the operation of the secondary throttle valve 51, it will be noted that this valve is adapted to swing on a pivot shaft 61 which carries an arm 62 to which is connected one end of a link 63. The other end of this link is connected to a second link 64 which extends through one end of a cylinder 65. Connected to link 64 is a piston 66 adapted to reciprocate within cylinder 65, a spring 67 acting to urge piston 66 to the right as viewed in Fig. 2 whereby to open the secondary throttle valve 51. The left end of cylinder 65 is open to intake manifold 13 by reason of a passageway 68 whereby to expose the left side of piston 66 to the pressure of manifold 13. The portion of cylinder 65 to the right of piston 66 is open to the atmosphere by reason of a very small vent hole 69 drilled in the cap 70, this vent acting as a dash pot for piston 66 when the latter suddenly moves within cylinder 65, the dash pot action being suplemented by a small amount of leakage from one end of cylinder 65 to the other past piston 66. A packing 71 is adapted to seal the other end of cylinder 65 so that link 64 may freely reciprocate without leakage of air past link 64 to the cylinder.

Loosely mounted on the end of the throttle valve shaft 61 is a bell crank lever 72 best shown in Figs. 3 and 4, this lever having an arm 73 carrying a pin 74 projecting into the path of the link 62, the latter being fixed to the shaft 61. The other arm 75 of bell crank lever 72 is fixed at 76 to a Bowden wire 77, the latter also extending downwardly for connection at 78 to an arm 79 of the pivot shaft 25 of the choke valve 24. This Bowden wire 77 is extended to a convenient point for manual actuation by the operator, as for example, through the dash 11 as seen in Fig. 1, the end of the wire having a suitable knob 80 adapted to be pulled outwardly from the dash to obtain the choking operation.

The operation of the primary throttle valve 30 is obtained from a suitable manually operable member such as the accelerator pedal 81 extending through an opening 82 in the toe-board 10, the pedal carrying an arm 83 having a pivotal support at 84 beneath the toe-board. The arm 83 is provided with a pin 85 adapted to operate in a slot 86 formed in an arm 87 of a bell crank lever 88 pivoted at 89 beneath the toe-board 10. The other arm 90 of this bell crank lever is adapted to be connected at 91 with a rod 92, the forward end of which is connected at 93 with a lever arm 94 fixed to the pivot shaft 95 of the primary throttle valve 30. The lever 94 also has the arms 96 and 97 respectively abutting a stop 98 so as to limit the opposite rotational movements of shaft 95 as the throttle valve 30 is moved between the limits of its opened and closed positions.

The operation of the device as thus far described, referring to the embodiment of our invention illustrated in Figs. 1 to 4, is as follows:

In Figs. 1 and 2 the position of the parts is such that the engine is idling. Thus, primary carburetor B has its throttle valve 30 substantially closed so as to permit only a relatively small

quantity of fuel mixture to pass to the manifold distributing chamber 18. Owing to this relatively small amount of air passing through the primary carburetor, spring 29 will act to close the air valve 26 whereby the relatively small amount of air being conducted through the air intake 19 will sweep below air valve 26 and upwardly along the idling jet 33 so as to pick up therefrom the required amount of fuel for extremely low engine load or idling. The supply of fuel to jet 33 is brought about by reason of the fuel pump 60 which maintains the level 55 of the float chamber 58, the fuel passing by gravity through conduit 36 to maintain the level 39 of the primary float chamber 34, the latter being open to the central fuel supplying conduit of the jet 33.

During this idling operation it will be noted that the secondary throttle valve 51 is closed by reason of the relatively high pressure difference in manifold 13, this relatively high manifold suction acting through the passage 68 so as to move the piston 66 to the left against the action of spring 67 whereby to swing the throttle arm 62 clockwise as seen in Fig. 2. In this manner the secondary carburetor C is not active since the closed position of the secondary throttle valve 51 prevents the passage of air through the cooperating secondary risers 15 and 17.

The fuel mixture passing upwardly in the primary riser portions 14 and 16 is conducted to the manifold distributing chamber 18, the secondary throttle valve 51 in such instance forming the roof or top wall of the chamber 18, the fuel mixture then changing its direction so as to pass longitudinally of the engine in opposite directions in manifold 13 for distribution to the various cylinders of the engine as will be readily understood.

When it is desired to place the engine A under an increased load, the operator depresses the accelerator pedal 81 whereby to swing the bell crank lever 88 on its pivot so as to actuate the link 92 and thus rotate the primary throttle valve shaft 95 in a counterclockwise direction so as to open the primary throttle valve 30. As the throttle valve 30 is opened, the air valve 26 will respond to the passage of additional air through the primary carburetor B, subjecting the flow of air across the additional jets 31 and 32 whereby to pick up additional fuel to accomm date the additional engine load determined by the degree of opening of the primary throttle valve 30.

As the fuel mixture passes upwardly of the primary risers 14 and 16, the wet fuel particles have a tendency to cling to the walls of the riser portions, this being accentuated by the directional effect given by the inclined throttle valve 30 which tends to deflect the fuel mixture against these walls. This wet fuel passing upwardly of the riser walls ordinarily has a tendency to spill over the upper end of riser 16 so as to be conducted along intake manifold 13 to a greater extent in one direction than in another and thus ordinarily certain of the engine cylinders tend to be supplied with a richer mixture than others. In order to overcome this tendency, we have provided the insert 42 which forms the downwardly extending annular pocket 43 adjacent the top of primary riser 16, the wet fuel particles being caught in this pocket and thus prevented from direct passage to manifold 13. The heating jacket 41 surrounding this pocket will vaporize a good portion of these wet fuel particles and in any event the tendency for localized or concentrated uneven flow of wet fuel particles along the riser walls is avoided by collecting the wet fuel around the insert 42. This wet fuel will then pass to the fuel mixture stream substantially uniformly, as for example, around the inner edge of the insert, the stream passing upwardly within insert 42 to chamber 18 whence it will be intermixed for equal distribution laterally of intake manifold 13 so as to materially improve the fuel mixture distribution characteristics of the carburetor and increase the efficiency of the engine.

The primary throttle valve 30 is preferably adapted to meet the demands of the engine for normal operating conditions until a predetermined desired power range is reached, whereupon the spring 67 will overcome the relatively small pressure difference in manifold 13 and progressively actuate piston 66 to the right so as to open the secondary throttle valve 51, it being understood that as the primary throttle valve 30 is opened in increasing amounts beyond the aforesaid predetermined range, the secondary throttle valve 51 will correspondingly be opened in increasing amounts.

As the secondary throttle valve 51 opens, the air stream passing through tube 47 will pick up fuel from the nozzle 48 for conduction downwardly through the secondary riser portions 15 and 17, the fuel mixture stream from the secondary carburetor impinging on the fuel mixture stream from the primary carburetor, the manifold chamber 18 receiving these oppositely moving streams so as to thoroughly intermix the streams and conduct the resulting mixture along the oppositely extending portions of intake manifold 13 for distribution to the engine cylinders. The kinetic energy of these moving streams is thus utilized, not only to effect an efficient mixture of the two streams, but also to increase the ramming effect in the manifold 13, this resulting in a substantial increase in the volumetric efficiency of the engine.

If desired, the primary throttle valve 30 and spring 67 may be so arranged, spring 67 being relatively light, whereby the primary carburetor B will meet the demands of the engine over a very substantial range of power requirements, such range preferably being the relatively low power range, the secondary carburetor C responding only to what might be termed the peak load or where the engine is used to propel an automobile the secondary carburetor C will respond to demands for relatively increased top speed performance of the vehicle. By reason of the fact that the secondary throttle valve 51 is responsive to the pressure difference in the intake manifold 13, it will also be apparent that the secondary carburetor C will also supply fuel mixture to the manifold so as to supplement the delivery of fuel mixture from the primary carburetor B whenever the accelerator pedal 81 is rapidly depressed so as to momentarily reduce the pressure difference in the manifold. This occurs when the vehicle is rapidy accelerated, the secondary carburetor C thus functioning to supply a momentary accelerating supply of fuel mixture to the engine.

It will be obvious that the relative positions of the primary and secondary carburetors may be reversed if desired or otherwise rearranged, although we prefer substantially the general arrangement of parts as illustrated in the interest of good performance and improved economy of operation.

As the accelerator pedal 81 is progressively depressed, the primary throttle valve 30 is likewise

progressively opened until it is in its full open position at which time the arm 97 is moved against the stop 98 so as to limit further movement. A spring 99 serves to restore the parts to the position shown when the operator releases the pedal 81.

When it is desired to choke the carburetors as is customary for starting the cold engine, the operator pulls the knob 80 so as to actuate the wire 77 to close the choke valve 24 whereby to cause the primary carburetor B to supply and enrich fuel mixture to the engine in accordance with well known present day cold engine starting practice. When the choke valve 24 is thus substantially closed, the bell crank lever 72 will also be actuated to the dotted line position of the parts as shown in Fig. 3 whereby to insure closing of the secondary throttle valve 51, the pin 74 acting against the throttle arm 62 so as to compress spring 67 during the choking operation. When the engine has been started, the resulting relatively high pressure difference in manifold 13 will then hold the secondary throttle valve 31 closed and the knob 80 may be returned to the position shown in Fig. 1.

It will be noted that our carburetors of the general types illustrated provide for fuel mixture temperature regulation proportional to the engine requirements without customary complicated mechanical heat controlling by-pass arrangements. Thus, throughout the range of the primary throttle valve, greater quantities of heat are applied to the primary fuel mixture in proportion to the quantity of air flowing through the primary carburetor. This is in the interests of best fuel economy.

When the primary and secondary throttle valves are both open, as for relatively high speed or acceleration, the spring loaded air valve will partially close since air can flow more freely through the relatively unrestricted secondary carburetor. Under such conditions the combined fuel mixtures receive relatively less heat, than when the primary carburetor is operating alone, thereby automatically providing best power output.

Referring now to the embodiment of our invention illustrated in Figs. 5 to 8 inclusive, it will be noted that many of the reference characters are duplicated in order to indicate parts of generally similar construction and operation. It is not deemed necessary or advisable to further comment in detail on such duplicated parts as their construction and operation will be readily apparent from the foregoing description in connection with Figs. 1 to 4 inclusive.

Figs. 5 and 7 illustrate the provision of a modified form of supplying the fuel to the primary and secondary carburetors B and C respectively, and referring more particularly to Fig. 5, it will be noted that the fuel supply pipe 59 communicates as before with the float chamber associated with the secondary carburetor, this float chamber being indicated as 52^a best shown in Fig. 6. The float chamber in this instance has a lateral auxiliary chamber 100 containing a cylindrical element 101 within which is located a tube 102 having its upper end spaced from the top wall of the element 101 and having its lower end in communication with the gravity feeding conduit 36 which, as in Fig. 2, conducts the fuel to the primary carburetor B. The cylindrical element 101 has an opening 103 for admitting fuel from float chamber 52^a for conduction around the tube 102 so that when the primary carburetor B is functioning, the resulting suction in conduit 36 will draw the fuel upwardly within the cylindrical element 101 and downwardly in the tube 102. The float chamber 52^a is vented as before at 56 and the cylindrical element 101 preferably has a somewhat smaller vent indicated at 104.

By reason of the suction speed produced by primary carburetor B, we are enabled to dispense with the provision of a float chamber for the primary carburetor, the fuel from conduit 36 preferably passing directly to the fuel chamber 35 for direct passage to the jets of the primary carburetor B.

In Fig. 5 the primary and secondary throttle valves 30 and 51 respectively, as well as the choke valve 24, are adapted to be operated in a manner similar to that previously described in connection with the embodiment illustrated in Figs. 1 to 4.

Referring now to Figs. 7 and 8, we have illustrated a somewhat modified form of control for the primary and secondary throttle valves, the choking operation being similar to that previously described. In Fig. 7 the secondary throttle valve 51 is responsive to movement of the accelerator pedal 81 instead of being responsive to the pressure difference of the intake manifold 13. Thus, the secondary throttle valve arm 62 is connected at 105 to a link 106 subjected to the action of a spring 107, the other end of link 106 being connected at 108 to a lever arm 109 pivoted at 110, the lever having a second arm 111. The end of lever arm 111 slidably receives a link or rod 112 one end of which is connected at 113 to the aforesaid arm 90 of bell crank lever 88, the other end of link 112 carrying an abutment or stop 114 adapted to engage the end of lever arm 111 so as to actuate the lever arm 109 about the pivot 110 as will be hereinafter more apparent.

Referring to Fig. 7 it will be noted that a second knob 115 is associated with dash 11, this knob being adapted to actuate a Bowden wire 116 connected to a locking dog or abutment 117 slidable in a guide 118 so that when knob 115 is pushed inwardly from the Fig. 7 position to the Fig. 8 position, the outer end of dog 117 will be projected as indicated at 119 into the path of the primary throttle valve arm 97 and prevent arm 97 from moving further toward the stop 98. With the knob 115 pulled outwardly as in Fig. 7, it will be understood that the dog 119 is retracted so as to allow the arm 97 to move to the stop 98 and thus fully open the primary throttle valve through an arc corresponding to the distance between dog 119 and stop 98. We desire to point out here that this additional movement of the primary throttle valve is not intended to materially increase the supply of fuel mixture from the primary carburetor B since, the primary carburetor is preferably supplying substantially its maximum quantity of fuel mixture delivery when the throttle valve arm 97 is positioned as in Fig. 8 against the dog 119.

With the parts positioned as shown by the full lines in Fig. 7, it will be apparent that the engine is idling, the secondary throttle valve 51 being closed and primary throttle valve 30 being substantially closed so as to pass only a relatively small quantity of fuel mixture in order to produce the idling operation. As the operator depressed the accelerator pedal 81 to the dotted line position 81^a of Fig. 7, it will be apparent that the primary throttle valve 30 will be opened to the position shown in Fig. 8, this range of accelerator pedal movement from 81 to 81^a rep-

resenting substantially the full range of fuel mixture supply for the primary carburetor B. During this range of accelerator pedal movement we prefer to have the parts arranged so that the secondary throttle valve 51 will not be opened, this relationship being illustrated by the positioning of stop 114 which, as shown in Fig. 8, is abutting the end of lever arm 111 so that on further movement of the accelerator pedal 81 the secondary throttle valve 51 will then progressively open.

During normal city driving for the automobile and preferably throughout the normal range of power requirements, the accelerator pedal is moved only to the position indicated at 81a whereby the primary carburetor B is supplying substantially the full requirements for power, the exception being when unusual acceleration is desired in which instance the operator has only to further depress the accelerator pedal 81 to the dotted line position indicated at 81b whereupon the secondary throttle valve 51 will be opened to supplement the delivery of fuel mixture to the intake manifold and thence to the cylinders of the engine. As the accelerator pedal is moved from 81a to 81b it will be apparent that the stop 114 will actuate the lever arm 111 so as to move link 106 and swing the secondary throttle valve 51 progressively from the position shown in Fig. 8 to its fully opened position. During this opening movement of the secondary throttle valve, the spring 107 will resist the movement of the accelerator pedal 81, supplementing the normal resistance produced by the spring 99, whereby the operator will be aware of the fact that he is drawing on the secondary carburetor C as well as the primary carburetor B. It is thus possible for the operator to control the vehicle with the parts including knob 115, as arranged in Fig. 7 and still operate the vehicle with the maximum economy and efficiency by actuating the accelerator pedal 81 only to the position indicated at 81a, further movement of the accelerator pedal toward the position indicated at 81b taking place only when the operator desires increased acceleration or temporary conditions of relatively high power output of the engine.

When it is desired to operate the engine and motor vehicle only by reason of the fuel mixture supplied by the primary carburetor B, the knob 115 may be moved from the position shown in Fig. 7 to the Fig. 8 position so as to prevent the accelerator pedal from traveling beyond the dotted line position 81a. This relationship of parts is shown in Fig. 8 in which the dog 119 is preventing further movement of the accelerator pedal 81, the secondary throttle valve 51 being maintained in its closed position.

Referring now to Figs. 9 to 12 inclusive, we have illustrated a further somewhat modified arrangement whereby hydrocarbons of different specific gravity may be introduced to the primary and secondary carburetors, these views also illustrating a further modified form of controlling the primary and secondary throttle valves in correlated fashion. It will be understood that the various methods of controls which we have illustrated are not limited as to their application to the particular types or arrangements of primary and secondary carburetors shown in association therewith, since the control of any one form or the equivalent thereof may be utilized to advantage with the arrangement of carburetors illustrated in one of the other forms as will be readily understood.

In Figs. 9 to 12 inclusive, similar reference characters represent parts previously described in structure and operation, although where such parts are modified in structure or operation they are given a further differing reference character.

Referring more particularly to Fig. 10, it will be noted that the primary carburetor B is substantially the same as that previously described, differing only in that the fuel is supplied directly to the float chamber 34 by a conduit 119 through which a fuel such as gasoline is pumped by any suitable type of fuel pump represented at 120 in Fig. 9. In Fig. 10 the manifold riser 16a is somewhat modified by the provision of the tubular conduit or riser extension 121 which extends partly across the manifold distributing chamber 18. We have also shown the riser insert 42a of slightly modified form, forming pocket 43a located inwardly from the riser outlet and thus slightly differing from the corresponding arrangement shown in Fig. 2. Also the insert 42a is perforated at 42b whereby to provide a plurality of fuel outlets uniformly around the walls of the fuel mixture being conducted therethrough. The function of the pocket 43a corresponds generally with that described in connection with the pocket 43 although in Fig. 10 the heating jacket 41a is not shown as surrounding the pocket 43a although if desired it may be extended downwardly around the pocket as will be readily understood.

The secondary carburetor C may be of the plain tube type just as illustrated in Fig. 2, the fuel being supplied under pressure from a pump 122 through conduit 123 to the usual float chamber 52. In the Fig. 10 arrangement, the fuel supplied to the secondary carburetor C is preferably a hydrocarbon having a heavier specific gravity than that supplied to the primary carburetor B, the fuel being kerosene, fuel oil, or other suitable fuel.

Where the secondary carburetor C is adapted to function with a relatively heavy fuel the secondary manifold riser 17a is modified to provide for the application of heat to the fuel mixture so as to vaporize the heavy wet fuel particles and thus more efficiently introduce such fuel mixture to the manifold distributing chamber 18. In Fig. 10, we have illustrated one arrangement consisting in a baffle 124 preferably opposite the fuel mixture stream issuing downwardly from the carburetor riser 15, this baffle having a central passage 125 adapted to receive a quantity of the exhaust gases circulating therethrough so that as the wet fuel particles strike the heated baffle 124 they will be vaporized and passed around the sides of the baffle through openings indicated at 126 to the lower wall 127 which may also be heated by the exhaust jacket 128. The exhaust jackets 41a, 125 and 128 are preferably communicating in any suitable manner with each other and with the exhaust pipe 12 as will be readily understood. The outlet portion 129 of the secondary manifold riser 17a may be provided with the tube 130 forming the annular ledge 131 adapted to collect any unvaporized wet fuel particles and hold such particles at the heated wall 127 until they are vaporized and also to uniformly distribute the particles around and into the stream whence they will pass downwardly through the secondary riser tube 130 for mixture with the gasoline and air stream supplied by primary carburetor B to the manifold distributing chamber 18. If desired the ledge 131 may be perforated to facilitate the atomization and distribution of the wet fuel particles.

The function of the riser extension 121 is to

conduct the fuel mixture stream from the primary carburetor to a point in proximity with the fuel mixture stream issuing from the secondary carburetor so as to more intimately break up the heavy fuel mixture, the resulting mixture of the two streams being conducted as before from the manifold distributing chamber 18 to the various engine cylinders. It will be understood that when the secondary carburetor C is inactive and the primary carburetor B is supplying fuel mixture to the engine, the secondary throttle valve 51 will be closed and the suction of the engine will direct the fuel mixture stream issuing from the primary carburetor laterally through the opposite runner portions of the manifold 13.

Referring to Figs. 9, 11 and 12, we have illustrated a still further modified arrangement for controlling the primary and secondary throttle valves, this arrangement being shown for purposes of illustration in combination with the arrangement of primary and secondary carburetors arranged as in Fig. 10. We have provided a primary accelerator pedal 132 pivotally mounted at 133 to the toe-board 10, this pedal operating a link 134 connected to a lever arm 135 having a fixed pivot 136, a second lever arm 137 rigid with arm 135 being connected at 138 to a rod 139. The other end of rod 139 is connected as aforesaid at 93 so as to actuate the primary throttle valve 30 in a manner similar to the actuation of the primary throttle valve illustrated in Fig. 2. The aforementioned spring 99 is adapted to restore the primary accelerator pedal 132 to the position illustrated in Fig. 9.

As a means of correlating the control for the secondary throttle valve 51 with the control of the primary throttle valve, we have provided a secondary accelerator 140 likewise pivoted at 133 but movable independently of the primary pedal 132. The secondary pedal 140 is connected through link 141 to a bell crank lever arm 142, the other arm 143 actuating a rod or link 144. The bell crank lever having arms 142 and 143 is pivoted at 145 to a fixed support and rod 144 is acted on by spring 146 tending to yieldingly restore the secondary pedal 140 to the position shown in Fig. 9. The rod 144 acts through a bell crank lever 147 and rod or link 148 to actuate the secondary throttle valve 51 by reason of the throttle valve arm 62.

The primary and secondary accelerator pedals 132 and 140 are preferably positioned so that the operator may actuate these pedals in sequential fashion by a continuous movement of his foot, Fig. 12 illustrating one arrangement by which this may be accomplished. In Fig. 12 it will be noted that the secondary pedal 140 is positioned forwardly of the primary pedal 132 so that the operator may actuate the pedal 132 independently of the pedal 140 throughout the entire range of movement of pedal 132. By advancing his foot slightly, it will be apparent that when pedal 132 is depressed into alignment with pedal 140, further movement of the operator's foot will move both of the pedals 132 and 140 in unison so as to open the secondary throttle valve 51 while the primary throttle valve 30 is substantially fully opened.

In the operation of the device illustrated in Figs. 9 to 12, it will be noted that in Fig. 10 the engine is idling, the secondary throttle valve 51 being closed and the primary throttle valve 30 being closed for its idling position. Let us assume that the operator desires to actuate the motor vehicle entirely by reason of the fuel mixture supplied from the primary carburetor. He will thereupon actuate the primary pedal 132 according to the power requirements, pedal 132 being capable of movement downwardly beyond secondary pedal 140 so as to open the primary throttle valve 30 to its wide open position, the parts then having the positions indicated by the full lines in Fig. 11.

When it is desired to supplement the activity of the primary carburetor, the operator slightly advances his foot on the primary accelerator pedal 132 so that when he depresses pedal 132 his foot will, after a predetermined opening movement of the primary throttle 30, engage the secondary accelerator pedal 140, further downward movement of his foot then progressively opening the secondary throttle valve 51 whereby to supply the fuel mixture from secondary carburetor C as a supplementary charge to that supplied by the primary carburetor B. The operator will likewise be advised of the activity of one or both carburetors by reason of the fact that when the primary carburetor is acting alone, spring 99 will alone resist movement of the pedal 132. However, when both of the pedals 132 and 140 are being actuated, springs 99 and 146 will together resist movement of these pedals and this increased resistance will be readily detected by the operator.

In Fig. 11 we have shown in dotted lines the positions of the parts when the secondary accelerator pedal 140 is depressed to its fullest extent whereby to open the secondary throttle valve 51 to supply the engine with the maximum quantity of charge from the primary and secondary carburetors.

Various modifications and changes will be apparent from the broad teachings which we have made and we do not limit our invention to the particular combination and arrangement of parts which we have described and illustrated as preferred embodiments.

What we claim as our invention is:

1. In a charge forming device for internal combustion engines of the type having an intake manifold for conducting the charge to the several cylinders of the engine, said manifold having a fuel mixture distributing chamber; said device having a primary riser extending upwardly to said chamber, means for heating the primary riser, a secondary riser extending downwardly to said chamber, said risers being substantially coaxial, a primary carburetor for said primary riser and a secondary carburetor for said secondary riser and shielded from said heating means associated with said primary riser, primary and secondary throttle valves for said carburetors respectively, means for supplying fuel to said carburetors, and means for manually operating said throttle valves whereby the secondary throttle valve is opened only after a predetermined opening movement of the primary throttle valve, whereby to relatively lower the temperature of the fuel mixture introduced into the engine during relatively high load engine operation.

2. In a charge forming device for internal combustion engines, a primary carburetor adapted to supply fuel mixture to the engine over the relatively low range of power output and including means for heating said fuel mixture, a secondary carburetor adapted to supply fuel mixture to the engine over the relatively high range of power output and including fuel mixture conducting means shielded from said heating means associated with said primary carburetor, control means for each of said carburetors, and manually op-

erated means actuating said carburetor control means whereby to control the engine power output over the entire range of engine operation, said carburetors both functioning during relatively high load engine operation.

3. In a charge forming device for internal combustion engines, a primary carburetor adapted to supply fuel mixture to the engine over the relatively low range of power output and including a heated fuel mixture conducting means, a secondary carburetor adapted to supply fuel mixture to the engine over the relatively high range of power output and including an unheated fuel mixture conducting means, a throttle valve for each of said carburetors for controlling their respective delivery of fuel mixture, and throttle control means adapted to open said throttle valves one after the other in timed sequence and timed to open the throttle valve of said secondary carburetor solely over the relatively high range of power output.

4. In a charge forming device for internal combustion engines, a primary carburetor adapted to supply fuel mixture to the engine over the relatively low range of power output and including a heated fuel mixture conducting means, a secondary carburetor adapted to supply fuel mixture to the engine solely over the relatively high range of power output and including an unheated fuel mixture conducting means, and a fuel mixture distributing chamber receiving fuel mixture from said carburetors in substantially opposite directions for mixing said heated and unheated fuel mixtures to relatively lower the temperature of the fuel mixture introduced to the engine during the relatively high range of engine power output.

5. In a charge forming device for internal combustion engines, a primary carburetor adapted to supply fuel mixture to the engine over the relatively low range of power output, a secondary carburetor adapted to supply fuel mixture to the engine over the relatively high range of power output, float chambers for supplying fuel to said carburetors respectively, means for supplying fuel to one of said float chambers, and means for supplying fuel by gravity from the last said float chamber to the other of said float chambers.

6. In a charge forming device for internal combustion engines, a primary carburetor, a secondary carburetor, throttle valve means for said carburetors, means for manually adjusting the throttle valve means of said primary carburetor, and engine suction controlled means for adjusting the throttle valve means of only said secondary carburetor.

7. In a charge forming device for internal combustion engines, a primary carburetor, a secondary carburetor, a primary throttle valve for the primary carburetor, a secondary throttle valve for the secondary carburetor, a manually actuable throttle adjusting member for actuating said primary throttle valve, means for actuating said secondary throttle valve in response to actuation of said manually adjusting member, and a second manually actuable member controlling the actuation of said secondary throttle valve actuating means.

8. In a charge forming device for internal combustion engines, a primary carburetor adapted to supply fuel mixture to the engine over the relatively low range of power output, a secondary carburetor adapted to supply fuel mixture to the engine over the relatively high range of power output, a manually actuable member for controlling the fuel mixture delivery of said carburetors, and means selectively rendering either the primary carburetor alone, or both of said carburetors, responsive to actuation of said manually actuable member.

9. In a charge forming device for internal combustion engines, a carburetor having a choke valve associated therewith, a second carburetor having a throttle valve associated therewith, means for conducting fuel mixture from said carburetors to the engine, means for manually actuating said choke valve, and means responsive to said choke valve actuating means for closing said throttle valve.

10. In a charge forming device for internal combustion engines, a primary carburetor adapted to supply fuel mixture to the engine over the relatively low range of power output, a secondary carburetor adapted to supply fuel mixture to the engine over the relatively high range of power output, a source of fuel supply, means connecting an interior chamber of one of said carburetors with said source of fuel supply, and means for supplying fuel by gravity from said chamber to said other carburetor.

11. In a fuel mixture feeding system for an internal combustion engine including a distributing chamber, separate conducting means for conducting fuel mixture to said chamber in opposed streams and meeting in said chamber, a primary carburetor functioning throughout the entire range of engine operation and delivering fuel mixture to one of said conducting means, means heating the fuel mixture delivered by said primary carburetor, and a secondary carburetor delivering a fuel mixture to said other conducting means solely during the relatively high load engine operation, said latter conducting means being shielded from said heating means, whereby to supply a heated fuel mixture for relatively low load engine operation and a relatively colder fuel mixture during high load engine operation, throttle valve means for each of said conducting means, and manually operated means for actuating said throttle valve means to control the passage of the fuel mixture through said conducting means in accordance with a prearranged plan of engine operation control.

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