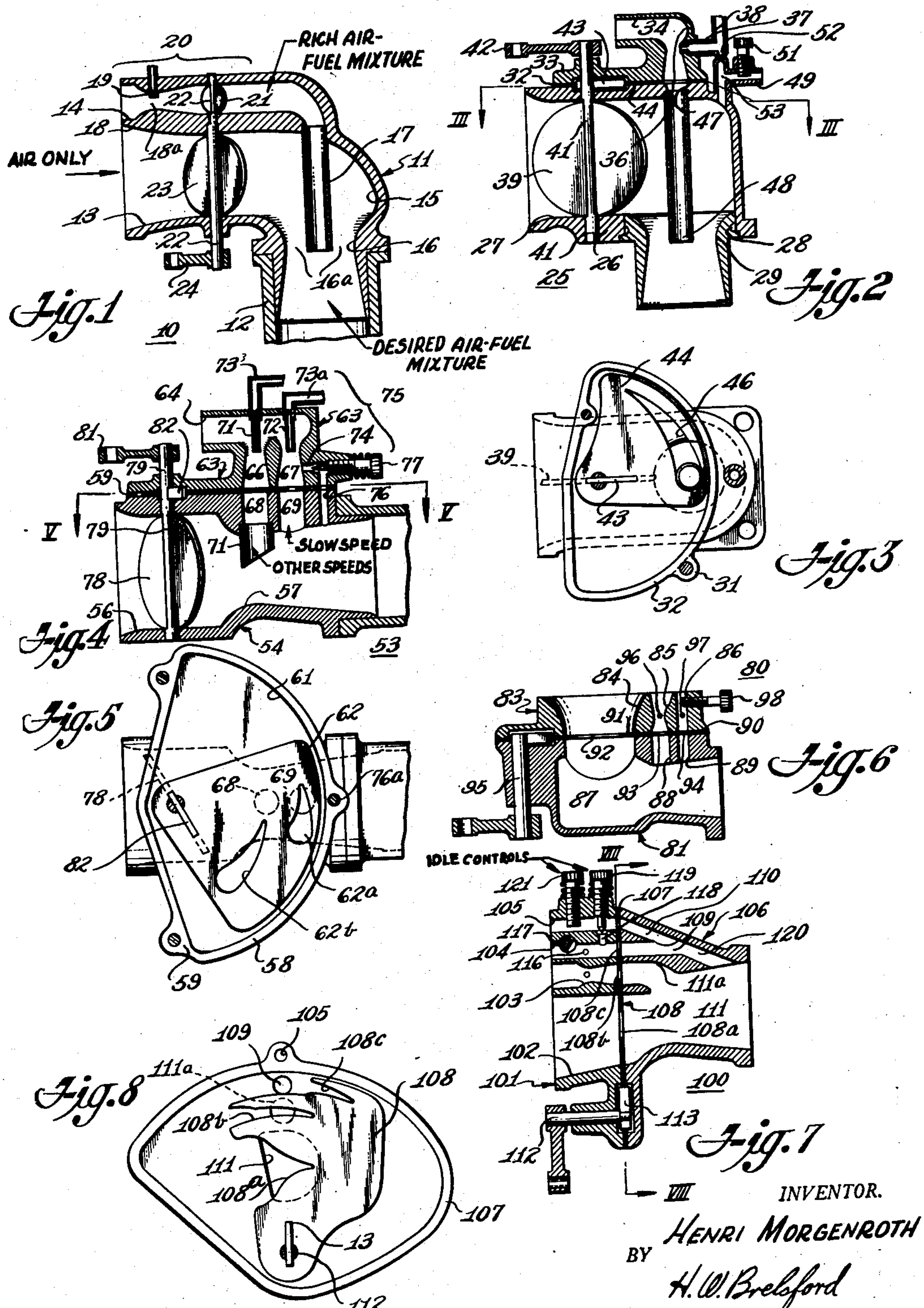
May 12, 1953 H. MORGENROTH 2,638,330

CARBURETOR

Filed Sept. 13, 1949



INVENTOR.

HENRI MORGENROTH

BY H. W. Brelsford

Attorney

Patented May 12, 1953 2,638,330

UNITED STATES PATENT OFFICE

2,638,330

CARBURETOR

Henri Morgenroth, Santa Barbara, Calif.

Application September 13, 1949, Serial No. 115,391

6 Claims. (Cl. 261—23)

1

My invention relates to carburetors and has particular reference to an improved method and apparatus for mixing fuel and air in a carburetor passage posterior to the flow control valve in said passage.

In general, my invention provides a carburetor that includes a rich mixture carburetor which discharges into a venturi through which combustion air is passed. A rich mixture carburetor as used herein means one that is designed or controlled to give a mixture richer than desired for the particular operating condition. The rich mixture is diluted by the air so that the final mixture is a desired fuel-air mixture suitable for combustion in the usual internal combustion engine. The air passage is provided with a flow control valve upstream from the point of discharge of the rich mixture or rich carburetor. The rich mixture carburetor is provided with a separate control such as the usual throttle valve or its equivalent. The rich carburetor may be of a conventional type wherein the throttle valve is downstream from a venturi where fuel is metered into the air. By proper synchronization and design of the flow control valve and the rich carburetor control valve, the correct mixing of the rich mixture and air may be effected as just described.

Carburetors have heretofore been employed that discharged fuel posterior or downstream from the throttle valve in an air intake passage. Such prior art carburetors are generally referred to as interior discharge carburetors. The fuel is discharged almost directly into the hot manifold or the manifold distribution zone. In aircraft carburetors this affords the advantages of greatly reducing icing hazards as the evaporation of the fuel occurs in a warm part of the apparatus and not in front of the butterfly or throttle valve. Accordingly, the drop in temperature induced by evaporization, which sometimes causes icing of the water or water vapor present in the air, cannot affect the throttle valve. Furthermore, in such interior discharge carburetors the fuel distribution in the air can be improved, since the fuel is not deflected by the throttle valve as in conventional carburetors.

Present day interior discharge carburetors are mostly pressure type carburetors, that means, that the fuel is fed under pressure into the carburetor and that the carburetor mainly consists of a metering system which reduces the pressure in accordance with the mass-air-flow. These devices are so complicated that they have only found application in expensive aircraft carburetors, despite the fact that the interior discharge is also highly desirable in most other applications.

My invention achieves the benefits of interior discharge carburetors by means of simple and in-

2

expensive apparatus and by utilizing my method of an automatic control of mixing air and a rich air-fuel mixture. My rich mixture carburetor is not subject to icing like conventional carburetors because it is small in size and therefore easier to keep warm to prevent icing. Furthermore, the rich mixture is not completely vaporized and droplets of warm fuel are present in the air stream to prevent freezing. Also, the booster is almost always wet from fuel and there is a reduced amount of condensation when additional fuel is introduced for acceleration. This is in contrast to conventional carburetors where the walls are dry at part load and upon acceleration fuel is condensed on the cold walls of the carburetor passages, necessitating "hot spots" and other forms of air warming. Accordingly, my carburetor gives an instantaneous response to acceleration demands.

It is, therefore, a general object of my invention to provide a simple carburetor having the advantages of interior discharge carburetors.

Another object of my invention is to achieve efficient carburetion by first carbureting air and fuel in a rich mixture and subsequently diluting to a desired combustion mixture by an automatic and predetermined process.

A further object is to produce a carburetor wherein the fuel is metered in a rich mixture carburetor forming a rich mixture which is diluted by a controlled air passage, the air and fuel being simultaneously regulated in such a manner as to produce a combustion mixture of the desired composition for each throttle position.

Still another object is to provide a carburetor of the type described wherein novel types of valves control the air and air-fuel mixtures and may be simply regulated in a complementary fashion to give the desired final mixture.

Other objects and advantages of my invention will be apparent in the following description and claims considered together with the accompanying drawings forming an integral part of this specification and in which:

Fig. 1 is a sectional view of a simplified or schematic type of carburetor embodying the elements of my invention;

Fig. 2 is a sectional view of a practical type of carburetor embodying my invention;

Fig. 3 is a view along the line III—III of Fig. 2;

Fig. 4 is a sectional view of a modified form of my invention and illustrating slow speed and high speed booster carburetors;

Fig. 5 is a view taken along the line V—V of Fig. 4;

Fig. 6 is a sectional view of a third form of a practical type of carburetor;

Fig. 7 is a sectional view of a fourth modification of my invention wherein the various passages are generally parallel; and

Fig. 8 is a view taken along the line VIII—VIII of Fig. 7.

Referring to Fig. 1 there is illustrated a carburetor 10 having a body 11 connected to an intake manifold 12. The body may be provided with an air passage or conduit 13 and a much smaller rich mixture carburetor passage 14. The air passage may be curved to form an elbow 15 and may terminate in a streamlined restriction or venturi 16. The rich carburetor passage 14 may terminate in a tube 17 disposed perpendicularly to the passage so that it may terminate at and discharge into the Venturi region 16*a*.

The rich mixture passage 14 may be provided also with a venturi 18 to form a restricted portion 18*a*. A fuel jet 19 may project into the passage at the region of the venturi and may be connected to a suitable fuel source such as the usual carburetor float bowl. The flow of air through the passage 14 may be controlled by a balanced throttle valve 21 generally referred to as a butterfly valve which may be mounted on the upper end of a rotatable shaft 22 journaled in the housing or body 11. The assembly thus described may be referred to as a complete rich mixture carburetor 20 including the passage 14, the venturi 18 and the throttle valve 21. The rich carburetor 20 is conventional in construction and operation with one exception: the size of the fuel jet with respect to the restriction 18*a* is large so that a fuel-air mixture results that is richer than conventional.

The flow of air through the air passage 13 may be controlled, for example, by a balanced flow control valve 23 secured to the shaft 22. A lever 24 may be mounted on the lower end of the shaft so that a suitable throttle-operating mechanism may be connected thereto.

The operation of the carburetor 10 of Fig. 1 is as follows. The rich carburetor 20 operates similarly to a conventional carburetor. The engine or supercharger creates a subatmospheric pressure in the manifold 12 so that air rushes into the passages 13 and 14 or pressure may be applied to the exterior of both passages. Air passing over the venturi 18 must speed up and hence causes a local decrease in pressure in the Venturi region 18*a*. This sucks fuel, for example gasoline, out of the jet 19 whereupon it mixes with the passing air. The amount of air is controlled by the throttle valve and as the amount is increased, the Venturi drop becomes greater, sucking out greater quantities of fuel to mix with the greater quantities of air.

The venturi 16 in the air passage 13 operates also to create a local low pressure in the restricted portion 16*a*. This causes the rich mixture to be sucked out of the tube 17, causing a certain and positive air flow in the booster carburetor even when the manifold vacuum is substantially eliminated which occurs with air valve openings greater than, for example, 20% to 80% depending upon engine R. P. M. The air venturi accordingly acts to meter rich mixture according to the air passing through the air venturi, so that the flow of booster mixture is a function of the air flow as well as of manifold vacuum, and of the rich carburetor throttle opening. The rich mixture mixes with the raw air at the Venturi region 16*a* resulting in a proper mixture of fuel and air to feed the engine. The exact proportion of air to fuel is obtained by synchronizing in a complementary fashion the throttle valve 21 with the flow valve 23. Thus, if for a given setting of the throttle valve a mixture six

times normal richness is created, then the setting for the flow valve will allow six times as much air as in the rich carburetor assuming that the final mixture desired is a normal or efficient mixture. If the valves are pre-set with respect to each other, the other variables such as fuel jet size, fuel pressure and venturi size may be selected to give the proper mixture.

I am aware that many types of carburetors have air valves to admit extra air at the higher engine speeds because of the characteristic of venturis to draw too much fuel at the high air flows. The rich mixture at the higher speeds is accordingly diluted by the admission of air. My invention differs from such carburetors in that my rich mixture carburetor mixture is much richer than in auxiliary air carburetors and further in that the mixing of air and fuel-air mixture occurs over the entire operating range of the carburetor and not at the higher speeds or outputs only. Additionally, the amount of rich mixture produced in my rich carburetor is varied, for a given throttle setting, by the changing volumes of air that pass through the air venturi 16*a* as engine speeds change under varying load conditions. The air venturi acts as a metering device for the rich mixture, a function that is entirely lacking in auxiliary air carburetors. Furthermore, this new combination makes possible the interior discharge design with the advantages just described.

The "normal" mixture of a carburetor is defined in terms of the amount of oxygen present in the air to burn the fuel carbureted or mixed therewith. If there is more fuel present than the oxygen of the air can burn, the mixture is said to be rich. If there is more than enough oxygen present to burn the fuel, the mixture is said to be lean and the engine is characterized by a loss in power. An idealized carburetor will mix the exact amount of fuel in the air that the oxygen present will burn so that there is no leftover oxygen or fuel. Such a mixture is referred to herein as a normal or efficient mixture.

In actual practice, however, few carburetors employ an efficient fuel-air ratio throughout the entire operating range. While mixture requirements vary according to the specific applications, as a general rule, the low speed and high speed part of the range employ rich mixtures, while the central or "cruising" part of the range employs a substantially efficient mixture. The end result is best referred to as a desired or predetermined fuel-air ratio. From the carburetor designer's standpoint, he is provided with a preselected curve wherein richness of mixture is plotted against engine speed and load. The rich parts of the operating range may be 20% to 70% richer than an efficient mixture, depending upon the engine design and the application.

The operating range of an engine and hence of the carburetor may be defined as the range over which it develops useful power. This is in contrast to low speed operation for the sole purpose of keeping the engine turning over so that it will be instantly available for power and which is generally known as an idle speed or range. Therefore, as used in this specification, the term operating range includes all engine speeds and corresponding carburetor air and fuel flow ranges wherein useful power may be extracted from an engine and generally excludes idle speeds, except the high speed standby speeds employed on compressors and the like.

Referring to Fig. 2 there is illustrated a carburetor 25 having a plate type valve for control of the rich mixture carburetor. A body 26 may have an air passage 27 formed therein terminating in a right-angled outlet 28 in which may be disposed a Venturi fitting 29.

The top part of housing 26 is flatted and enlarged as at 31, illustrated in Fig. 3. A gasket 32 may be imposed on the outer rim of this flatted portion and an upper housing 33 may be clamped thereto which may have a rich mixture carburetor passage 34 formed therein. The rich passage may have a restricted Venturi portion 36 through which may project a fuel jet 37 supplied by fuel through a conduit 38. The conduit 38 may be connected to any suitable source of fuel such as a carburetor bowl.

Air flow through the air passage 27 may be controlled by a suitable valve such as butterfly valve 39 mounted on pivotal stem 41 journaled in the housings 26 and 33. The shaft may project through the housing 33 and have a lever arm 42 connected, so that a suitable carburetor actuating mechanism may be connected. Secured to an upper portion of the control shaft 41 may be a transverse reinforcement member 43 to which may be secured a plate valve 44. The plate valve 44 may be of slightly thinner material than the gasket material 32, so that it may move freely within the recess created by the gasket. The plate valve 44 may have a suitable aperture 46 formed therein so that the amount of mixture from the rich carburetor passage 34 will be regulated according to the position of the air flow valve 39. Thus the plate valve 44 takes the place of the throttle valve 21 illustrated in Fig. 1. The rich carburetor passage 34 terminates at the plate valve 44. The housing 26, however, is similarly apertured in registry with the rich passage as at 47 and a suitable tube 48 may connect this passage to the air of the air venturi 29.

I also provide in the embodiment of Figs. 2 and 3 an idle arrangement that is independent of the rich mixture valve and the air valve. This idle arrangement may include an air bleeder inlet tube 49 which may be adjustably controlled by a thumb screw 51 threaded therein. The fuel inlet 38 may be provided with a restricted portion 52 through which fuel may be metered which will mix with bleeder air at 53. By suitably selecting the fuel restriction 52 with respect to the adjustable opening into bleeder tube 49, the proper range of idle mixture may be readily obtained.

The operation of the carburetor of Figs. 2 and 3 is similar to that of Fig. 1 except for the idle fuel supply. In the position illustrated, the plate valve 44 has the widest part of the control aperture 46 disposed over the booster passage 34, so that a maximum amount of air is drawn through the rich mixture passage. This air is also drawn past the Venturi restriction 36, so that fuel may be injected by the jet 37 and the subsequent mixture will pass through tube 48 to the air venturi 29. At the same time, the butterfly valve 39 is also in its widest position permitting a maximum amount of air to pass creating the required low pressure area at the air venturi 29. This Venturi low pressure draws mixture from the rich carburetor even when manifold vacuum is eliminated. The rich mixture carburetor formed by the passage 34, the venturi 36 and the jet 37 accordingly delivers a very rich mixture to the air venturi 29, which mixture is then diluted with the raw or plain air at that point.

As lesser amounts of power are required from the engine to which the carburetor 25 is connected, the shaft 41 may be rotated by lever 42 causing the butterfly valve 39 to rotate in a clockwise direction with respect to Fig. 3. The plate valve 44 rotates in the same direction also. The slot 46 is tapered along an arc centerline and accordingly, the size of passage 34 will be reduced causing lesser amounts of air to pass through the passage 34 giving a greatly reduced amount of fuel injected into the rich carburetor stream by the jet 37. The passage vacuum created by the air venturi 29 or by manifold vacuum will act on the bottom surface of the plate valve 44 causing it to snugly engage the flatted top 31 of the housing 26, so that there will be no air leakage around the plate valve. The good seal created by this vacuum-plate arrangement makes it possible to eliminate the usual idle compensations for air leakage around butterfly and other types of throttle valves.

A ratio of cross section area of the rich mixture passage controlled by the plate valve 44 as compared to the cross sectional area opened by the butterfly 39 gives the ratio of rich mixture to air and thus determines the fuel-air ratio. This gives a method of calibrating the carburetor perfectly to the fuel-air ratio required by the engine. Inasmuch as the plate valve 44 may be simply formed by a punching operation, the selected ratio can be obtained quickly and cheaply in production with reliable accuracy.

The plate valve 44 may be formed of any suitable material and at present, I prefer to form it of stainless steel or phosphor bronze sheet by a punching operation, although other suitable materials and forming techniques could be employed. The gasket 32 may also be formed of a sheet material for accuracy and may be formed of a shim stock of sufficiently greater thickness to give freedom of movement to the plate valve 44, or may be replaced by a rim formed by one of the housings.

The operation of the idle arrangement of Fig. 2 is conventional in that air is drawn through bleeder 49 to mix with air drawn from the fuel restriction 52. It is well known, however, that as soon as the air valve 39 is opened, the manifold partial vacuum existing at the idle system will be substantially reduced, reducing the output of the idle system. However, I shape the slot in my plate valve 44 in such a way as to make the change over from idle operation to an operating condition in a smooth fashion. Accordingly, the small end of the valve aperture 46 is so positioned as to admit a small quantity of rich mixture from the rich mixture venturi 34 when the air valve is opened slightly. The rich mixture will be admitted from booster 34 compensating for the sudden decrease in mixture from the idle arrangement. In other words, the change over from an idle jet to the main jet can be perfectly blended by means of a compensating flow from the booster carburetor, which flow can be selected by any suitable shape of the slot 46.

Illustrated in Figs. 4 and 5 is a further modification of my invention wherein two rich mixture carburetors are employed to cover different parts of the operating range. The use of this two-stage type of rich carburetor is facilitated by a plate valve which has a separate opening for each of the different stages, the openings being effective at different positions of the plate. A carburetor 53 may have a body member 54, having an air passage 56 formed therein, including a restricted Venturi portion 57. The upper part of the body member 54 may be enlarged and flatted as at 58, so that a gasket 59 may define a narrow flat operating chamber 61 within which a plate valve 62 may operate. A rich mixture carburetor housing 63 may be secured to the enlarged part 58 and may include an inlet passage 64 terminating in two Venturi branches 66 and 67. The body member 54 has corresponding passages 68 and 69, formed in registry with the Venturi passages 66 and 67 respectively. The forward passage 68 is formed at the most restricted part of the venturi 57 and a short diagonal cut tube 71 may project from the end of this passage so as to distribute a rich mixture into the central part of the air flow.

Separate fuel jets 71 and 72 are provided for each Venturi passage 66 and 67 and may be fed by fuel conduits 73 and 73*a*. The low load jet 72 is smaller than the high load jet 71 and preferably but not necessarily the venturi is smaller than the venturi 66. The Venturi passage 67 may have a branch passage 74 that leads therefrom and which communicates with a registered passage 76 through an aperture 76*a* in the gasket 59. A thumb screw 77 may have a needle-point to control the effective opening of the idle passage 74.

The air passage 64, together with the venturis 66 and 67, the idle passage 74, the jets 71 and 72 and the plate valve 62 form a complete two-stage rich mixture carburetor designated generally by the numeral 75. More manageable carburetion results when a small size jet is used for low load and a large size fuel jet for high loads. The low load stage works on a higher pressure drop because of the greater manifold vacuum at low load. This makes possible the use of a small orifice at 72 which in turn permits less sensitive fuel level control in the float bowl. The large jet 71 operates primarily on the Venturi action of venturi 66, which develops a substantial pressure differential but only at high loads and air flows. Here also the liquid level control can be insensitive.

The air flow through the air passage 56 may be controlled by a suitable valve such as a butterfly 78, secured to a rotatable shaft 79, journaled in the housing 54 and projecting through the upper housing 63, permitting a lever arm 81 to be secured thereto for operation. A reinforcement member 82 may be secured to the shaft 79 to facilitate attachment of the plate valve 62 thereto.

Referring particularly to Fig. 5, it will be noted that the plate valve 62 may have two apertures 62*a* and 62*b* formed therein controlling the Venturi flow through passages 69 and 68, respectively. Inasmuch as the opening movement for the plate valve 62 and the butterfly 78 is by a counterclockwise motion, the valve opening 62*a* will first admit the passage of rich mixture from the carburetor 75 and accordingly, this is the low load operation aperture. The tail of the tapered high load aperture 62*b* overlaps the aperture 62*a* in its circular motion and controls the rich mixture from the venturi 66 for parts of the operation range other than low load operation. By properly overlapping the low load and the other load apertures, the change over from low load to other loads can be made smoothly.

In the operation of the carburetor of Figs. 4 and 5, there are several stages of a rich mixture carburetor employed. The use of two stages of the rich carburetor permits more efficient operation in view of the fact that it makes possible the use of a large portion of the manifold vacuum for metering the fuel through the small orifice 72 over a substantial portion of part load operation. Upon the opening of valve 78 corresponding to 30% to 70% of the load of the engine, the manifold vacuum is substantially reduced. At wide open throttle, the venturi of the air stream must be relied upon to produce operating vacuum for the rich mixture carburetor. The low load stage (jet 72 and venturi 67) operates primarily on manifold vacuum while the high and middle load stage (jet 71 and venturi 66) operates on manifold vacuum and air Venturi drop. The change over from one to the other may be gradual. Because the low load stage operates primarily on manifold vacuum it need not terminate at the air stream venturi.

The idle system of Figs. 4 and 5 differs from that of Fig. 2 in that a rich mixture is obtained at the venturi 67 and is bypassed through the passage 74 to the manifold, the plate valve 62 closing off the flow to the passage 69 during idle. As the valve is opened slightly for slow-speed operation, the point of the aperture 62*a* will admit an additional amount of rich mixture from venturi 67 for low load operation, the amount increasing with the valve opening. The idle adjustment of Fig. 4 accordingly does not affect the major part of the slow speed operation and hence an allowance for it need not be made in the plate apertures other than in the blunt tip of aperture 62*a*. By properly designing the shape of the aperture 62*a*, the change over from idle to low load may be made very smoothly.

Multiple Venturi carburetors have heretofore been employed but it has always been difficult to make the change over smoothly. The arrangement of the slotted plate valve in combination with an upstream control of the air flow makes it possible to meter the fuel correctly and smoothly from one venturi to the other. Further, it will be appreciated that there could be more than two venturis in my carburetor if this proved desirable. The slow speed fuel orifices have a smaller cross sectional area than the intermediate or high speed fuel orifices. The relative sizes of the associated venturis, however, is not critical.

Illustrated in Fig. 6 is a further modification of my invention wherein the idle stream, the booster carburetor stream and air flow are controlled by means of a single plate valve. Such a type of carburetor is useful on small engines where the carburetor may be made small and thus the frictional forces on the plate valve may be small when pressed against the body member by vacuum. It is also useful on engines having one or two cylinders where the air flow is pulsating and the manifold vacuum is intermittent, so that movement of the plate valve may readily be made between pulsations of the manifold vacuum.

Referring to Fig. 6, a carburetor 80 may include a body member 81, having an enlarged flatted upper portion on which may be disposed a gasket 90 upon which may be disposed an upper housing 83 having an air inlet 84, a booster Venturi passage 85 and an idle and low load passage 86 formed therein. The body member 81 may have an air passage 87 formed therein, as well as a passage 88 registered with the venturi 85 and the passage 89 registered with the low load passage 86. A plate valve 91 may have an air opening 92 as well as a rich mixture high load opening 93 and a low load opening 94 formed therein. The plate valve may rotate by means of a shaft 95 to which it may be secured. Fuel may be supplied to the venturi 85 by a fuel passage **96** and to the low load passage by a fuel passage **97**. A thumb screw **98** may control the air flow in the low load passage **68**.

The operation of the carburetor in Fig. 6 is controlled by the plate valve **91** which may have a minute opening in the aperture **94** when the air passage **84** and the venturi **85** is closed off. The high manifold vacuum under idle conditions will cause air to flow into passage **86** drawing fuel from the passage **97** to form an idle mixture. The thumb screw **98** may partially close the passage to act as a choke to cause a proper vacuum for the extraction of fuel from the passage **97**. No venturi is used in the idle passage of this modification.

As the plate valve **91** is rotated above very low loads, the Venturi passage **85** will be opened. All three slots may be suitably contoured to give the correct air-to-fuel ratio at all stages of the operating range.

Illustrated in Figs. 7 and 8 is a modified form of the carburetor in Fig. 6 wherein all passages are generally parallel. Accordingly, carburetor **100** may have an outer housing **101**, having an air passage **102**, a rich mixture Venturi passage **103**, a low load, rich mixture passage **104** and an idle passage **105**. A rear housing **106** may be separated from the forward housing **101** by a gasket **107** which defines a flat chamber for a plate valve **108**. The rear housing may have a forked slow speed and idle passage **120** having branches **109** and **110** registered with passages **104** and **105** as well as a main air Venturi passage **111** communicating with the air opening **102** and the booster venturi **103**. The communication with the rich passage **103** may be by means of a branch passage **111***a*. The branched passage **120** may communicate with the air passage **111**. The plate valve **108** may be secured to a rotatable shaft **102** by means of a reinforcement member **113**. The plate valve **108** may have an air slot **108***a*, a rich mixture slot **108***b* and a low load slit **108***c*. The gasket **107** may have an aperture **105** for the idle mixture branch **110**.

The low load and idle system of Fig. 7 includes the passage **104**, which may have a fuel jet **116** connected thereto which passage may be choked by a rotatable flatted stem **117** passing therethrough. The choke **117** is preferably actuated by operator and is not a fixed setting but in the open condition does not completely open passage **104**. An aperture **118** may connect the passage **105** with **104** posterior to the fuel jet **116**. This transverse rich mixture passage **118** may be controlled by a thumb screw **119**. The air flow through the passage **105** may be controlled by a thumb screw **121** threaded into it.

The operation of the carburetor Figs. 7 and 8 is as follows: When the plate valve **108** is rotated completely to the left (Fig. 8) all of the passages, except the constantly open idle mixture passage **105** will be closed When the engine is started, manifold vacuum will cause air to flow through passage **105** and rich mixture through the transverse connector **118**. By properly choking both **105** and **104**, fuel will be vaporized from the jet **116** and will flow through the transverse passage **118** to be mixed with air in passage **105** in the correct proportion. By operating the screw restrictor **121**, together with the needle valve **119**, the proper mixture and the proper air-fuel volume may be obtained for idle operation.

For low load operation, the plate valve **108** may be rotated to the right (Fig. 8) until the tip of slit **108***c* opens passage **109**. The choke **117** will operate to produce a mixture that will pass through the plate valve and the passage **109**. When the valve opening somewhat exceeds the opening of passage **118**, most of the mixture will flow through the valve, although passage **105** will continue to supply part of the low load mixture.

For higher engine loads the plate valve (Fig. 8) is rotated farther to the right or clockwise, causing the slot **108***b* to uncover rich mixture passage **111***a*. This permits air to flow through the rich mixture venturi **103** extracting fuel from the jet **124** to form a mixture that may be several times richer than normal. At the same time the air slot **108***a* will permit air to flow through the passage **111**. The various slots may be suitably contoured to give the correct air-fuel mixture at all operational speeds and to meet all load characteristics of the engine to which the carburetor is attached.

One of the advantages of the idle systems of Figs. 4 and 7, is that the idle adjustment affects idling only, and not the low speed range.

My so called low load rich mixture carburetors not only serve in the idle range, but may furnish fuel up to as high as 70% of the load. Although primarily designated as low load systems, they are in effect rich mixture carburetors working in a lower load range than the main carburetors. The restrictions in the idle and slow speed passages need not be venturis as volumetric efficiency is not important in this range.

It will be noted that the plate valve **108** of Fig. 8 differs from that of Fig. 5 in that the idle slot extends over the whole range. This permits the low speed or idle passages to remain open during intermediate and high speed parts of the operating range.

This modification of the slot arrangements also makes it possible to contour the slots in such a manner that, when the high load slot **108***b* cuts in, correct fuel air ratios can be maintained.

The word "slit" applies to cuts in an edge as well as apertures, and it will be used herein as generic of both types of plate valve shaping. The word "profiled" is also used herein to describe a plate valve having especially shaped or contoured apertures or cuts in an edge and hence, is generic also.

It will be appreciated that the proper operation of the plate valve can be obtained if a passage has a special outline where it is intersected by the plate valve. Hence, the control depends upon the relative shaping of the plate and passage. Since the plate is easier to profile than passage, the profiled plate is presently preferred. The required performance curve may be readily followed by cutting slits of corresponding shape. Also it should be noted that separate housings are not required to define a flat space within which the plate valves may operate as a narrow slot could be formed in which the plate slides.

My rich mixture carburetors may have the usual compensating mechanisms if desired, for example to correct for the changing fuel characteristic of venturis as the air flow volume changes. Thus if substantial load changes occur for a given valve setting the changing R. P. M. of the engine will not result in a change in mixture since compensators can be built into the rich mixture carburetors.

While I have described my invention with respect to specific embodiments thereof, I do not limit myself to these specific embodiments thereof, nor otherwise, as various modifications may be made as come within the true spirit and scope of my invention. While prior art devices have attempted to meter solid fuel by plate valves, such as I have illustrated, this control has been too critical, and hence, has been unsatisfactory for factory production techniques. By using the plate valves on the much less sensitive air-fuel mixture, I obtain very accurate control by means of a plate valve that may be quickly and cheaply mass-produced. Furthermore, the new plate valve will be sucked tightly on its seating surface, being subjected to the manifold vacuum, and having a large area. Solid fuel metering plates do not show this good sealing characteristic, being small in area and being subjected to low Venturi suction only. Hence I have illustrated various types of controls for such a rich air-fuel mixture.

Various combinations of parts other than those illustrated are possible as there is no limit to the relative configurations of air passages, carburetor passages, and passages connecting the two. Nor need the rich mixture carburetors or the fuel dump directly into the air passages, as suitable air bleeds could be used as an intermediate agency. Different types of idle systems could be used on any type of rich mixture carburetor or on any type of air passage and likewise any types of rich mixture carburetors could be used with any type of air passage. The air valves as well as the throttle valves could be of any desired type and could, for example, be gate valves, plug valves, rotary valves, sliding strip valves, slide cylindrical valves, etc., and hence, I do not limit myself to any type of valve illustrated. Nor need the plate valves illustrated be rotary, as they could with equal effect have a rectilinear motion without affecting the operation in any manner. Further, the plates need not be flat, but may be cylindrical or other shape. Chokes could be provided for any of the carburetors illustrated by the simple medium of placing an extra valve anterior to the fuel jet or the air control valve. Also any type of choke valve could be used in the high load carburetor as well as in the low load carburetors. The throttle valves and the air valves may be connected in any desired manner; for example, by compensating mechanical connections which might take into account altitude, temperature changes, etc. Also the coupling could be hydraulic or electrical, if desired.

The provision of the plate valves for control of the rich fuel mixture makes possible the custom designing of a valve according to the engine characteristics or the load characteristics of the engine, as well as temperature conditions. For example, compressors generally operate under much different fuel-air ratios than do automobiles or other types of applications.

The usual "economizers" common in automotive and aircraft carburetors to provide a rich mixture at full load can be replaced in my carburetors by the same valving mechanism that governs the rest of the range, by the simple expedient of shaping the valves, and hence the extra element can be eliminated.

In view of the foregoing, therefore, I do not limit myself to the embodiments illustrated or described, but claim all such modifications as come within the true spirit and scope of my invention.

I claim:

1. A charge forming device comprising means defining an air passage, a control valve disposed in the passage, an air venturi disposed in the air passage posterior to the control valve, at least one rich mixture carburetor delivering substantially its entire output at the air venturi and having a carburetor passage, mixture venturi, a fuel jet at the mixture venturi and a throttle valve in the carburetor passage, and having the parts so arranged as to give a mixture that is richer than desired, a mechanical connection coupling the control valve with said throttle valve over the operating ranges of the charge forming device so that the valve movements are complementary and simultaneous to produce a desired air-fuel mixture; characterized by at least the rich mixture carburetor throttle valve being a plate valve having a variant aperture movable transversely across its respective passage and providing a variable effective opening dependent primarily upon plate position relative to its respective passage.

2. A charge forming device as defined in claim 1 wherein each valve is a plate valve of the character as defined therein.

3. A charge forming device as defined in claim 1 wherein the control valve and the throttle valve are plate valves of the character as defined therein and formed as a common plate.

4. A charge forming device comprising an air passage, a Venturi restriction therein, a flow control valve for the passage anterior to the venturi, at least one low load rich mixture carburetor having a carburetor passage and discharging a rich mixture into the air passage posterior to the valve, at least one rich mixture carburetor for intermediate and high speeds having a carburetor passage and discharging a rich mixture into the air passage at the air venturi, a plate valve for each rich mixture carburetor movable transversely across its respective carburetor passage, said plate having a variant aperture providing a variable effective opening dependent upon its position relative to its respective passage, and a control system coupling the control valve and the plate valves so that the right mixture from all of the carburetors and the air form a desired mixture at all control valve positions.

5. A charge forming device as defined in claim 4 wherein the plate valves are formed of a single sheet of material.

6. A charge forming device comprising means defining an air passage having a Venturi restriction, a control valve in the passage anterior to the venturi, a rich mixture carburetor having a carburetor passage and discharging a rich mixture into the air venturi, a plate valve movable transversely across the carburetor passage for controlling the same, said plate valve having a variant aperture providing a variable effective opening dependent upon its position relative to the carburetor passage, and a mechanical connection between the control valve and the plate valve for simultaneous movement.

HENRI MORGENROTH.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
1,778,904	Loutz	Oct. 21, 1930
1,833,196	Aseltine	Nov. 24, 1931
1,882,722	Aseltine	Oct. 18, 1932
1,929,194	Teeter	Oct. 3, 1933
1,935,801	Koehly	Nov. 21, 1933
1,978,664	Aseltine	Oct. 30, 1934
2,254,834	Betry	Sept. 2, 1941
2,325,546	Regar	July 27, 1943