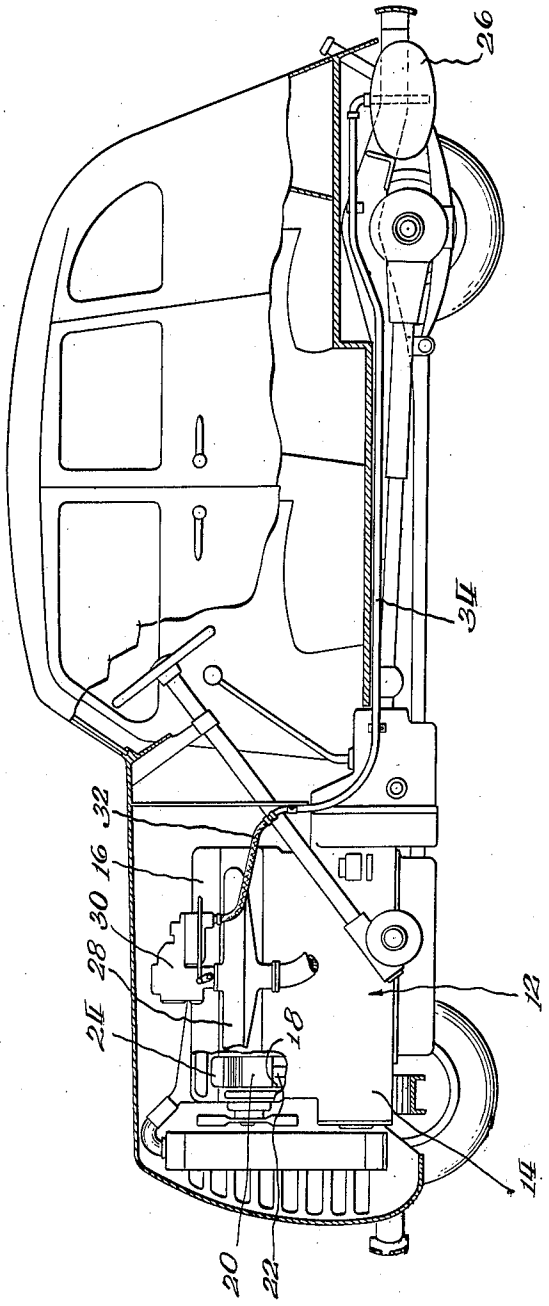
Jan. 27, 1942. R. F. BRACKE 2,271,114

METHOD OF AND MEANS FOR SUPPLYING COMBUSTIBLE MIXTURES TO INTERNAL COMBUSTION ENGINES

Filed July 27, 1938 4 Sheets-Sheet 1

Fig. 1.



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METHOD OF AND MEANS FOR SUPPLYING COMBUSTIBLE MIXTURES TO INTERNAL COMBUSTION ENGINES

Filed July 27, 1938 4 Sheets-Sheet 2

Fig. 2.

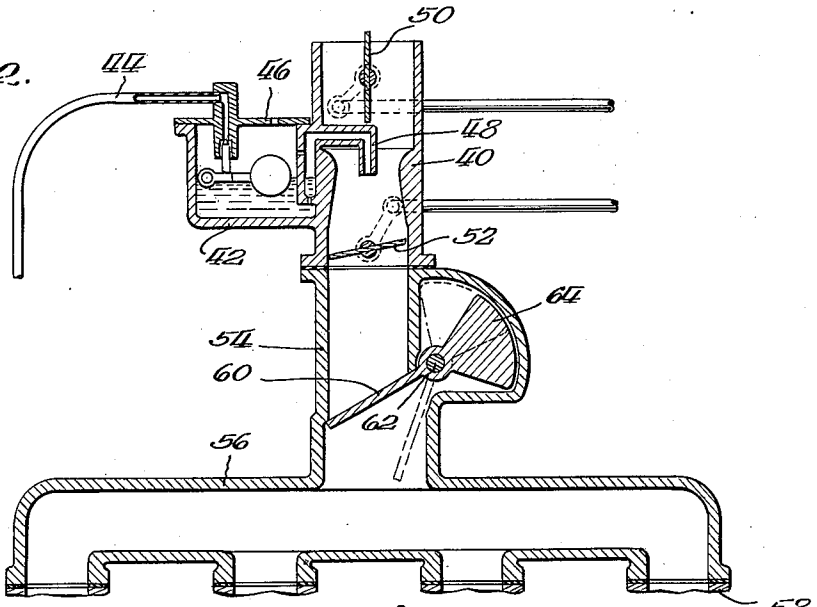
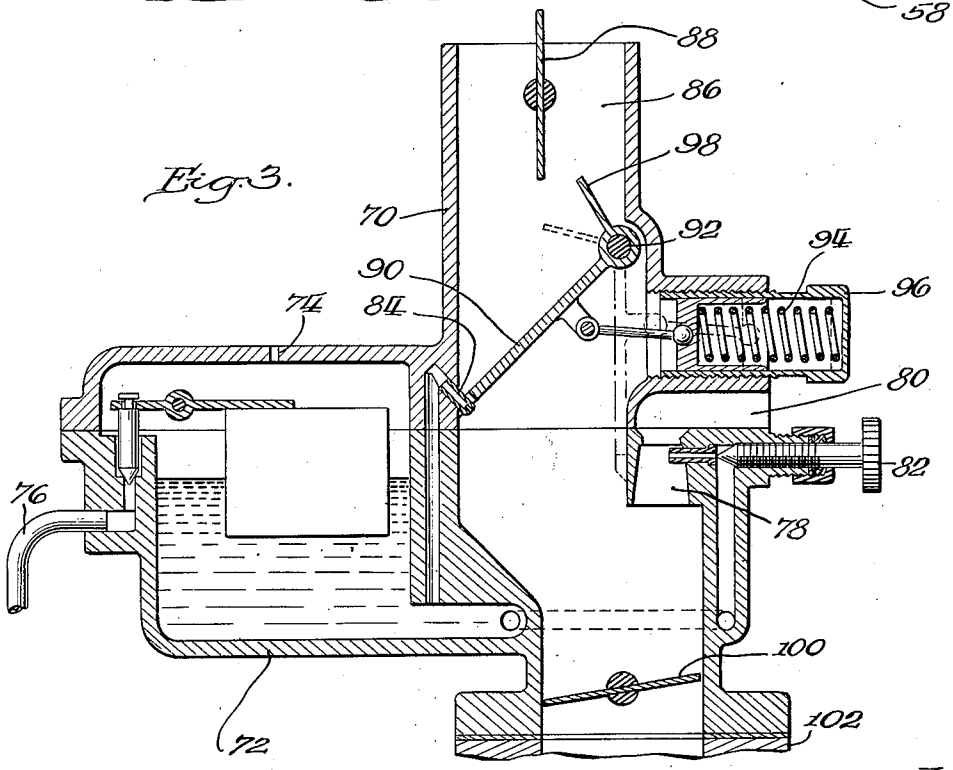


Fig. 3.



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METHOD OF AND MEANS FOR SUPPLYING COMBUSTIBLE MIXTURES TO INTERNAL COMBUSTION ENGINES

Filed July 27, 1938 4 Sheets-Sheet 3

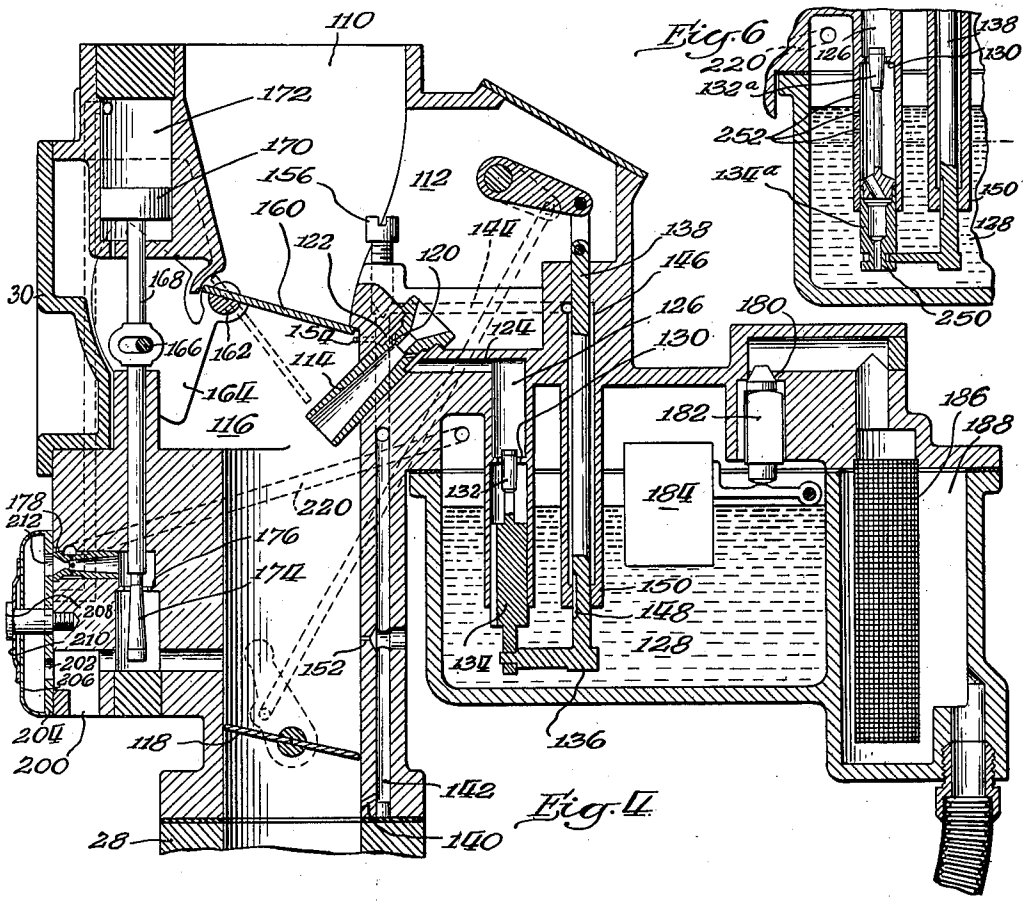


Fig. 6

Fig. 4

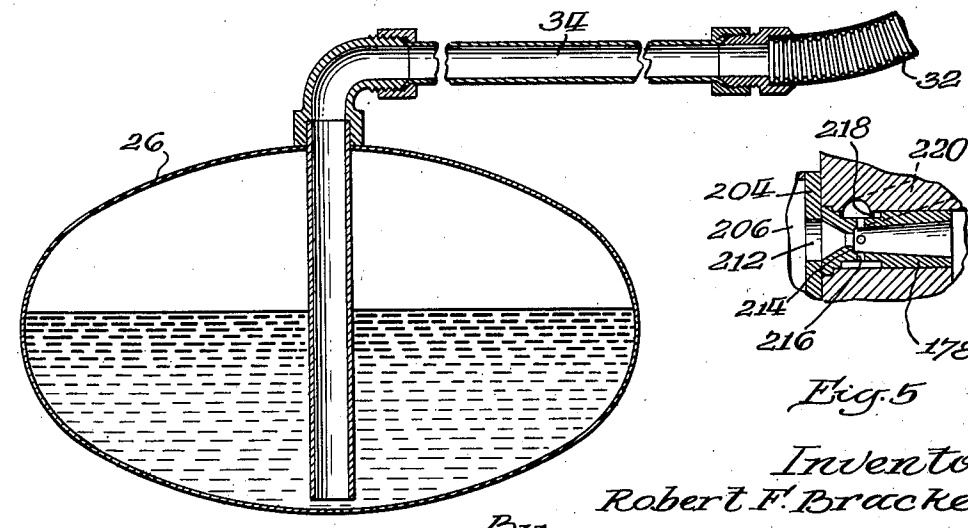


Fig. 5

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METHOD OF AND MEANS FOR SUPPLYING COMBUSTIBLE MIXTURES TO INTERNAL COMBUSTION ENGINES
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Fig. 7.

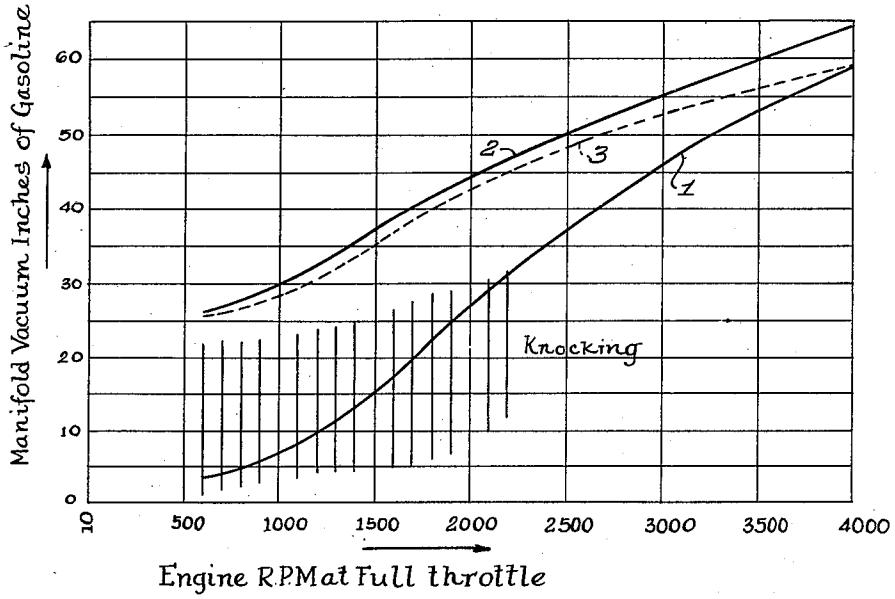
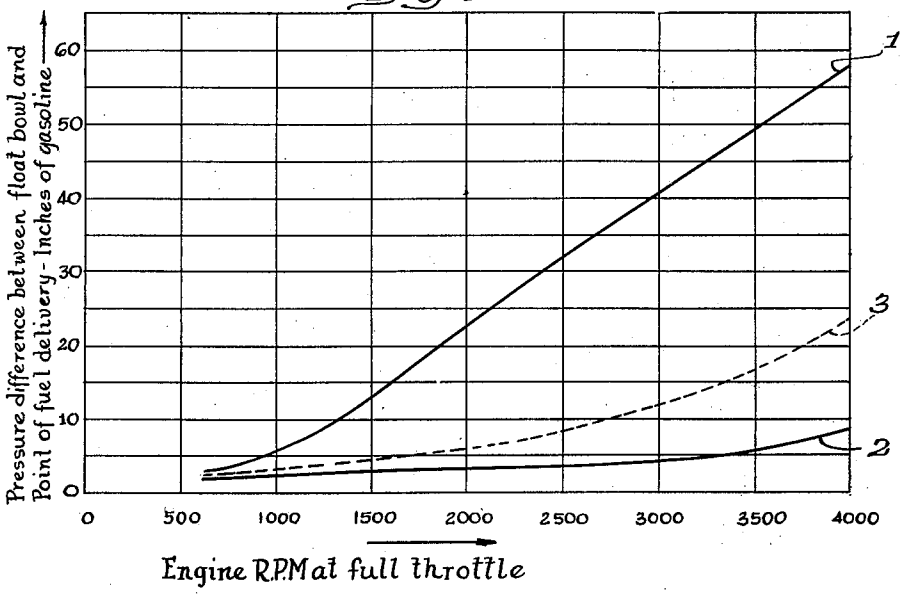


Fig. 8.



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Patented Jan. 27, 1942 2,271,114

UNITED STATES PATENT OFFICE

2,271,114

METHOD OF AND MEANS FOR SUPPLYING COMBUSTIBLE MIXTURES TO INTERNAL COMBUSTION ENGINES

Robert F. Bracke, Chicago, Ill.

Application July 27, 1938, Serial No. 221,485

1 Claim. (Cl. 123—119)

My invention pertains to a method and means for supplying combustible mixtures to internal combustion engines and is particularly adapted for modern automobiles.

In general, it may be stated that it is desirable to use as high a compression ratio in the automobile engine as is possible without producing knocking of the engine when operating on the usual commercial gasoline. The compression ratio which can be used without knocking of the automobile engine depends somewhat upon the materials used in the automobile engine and particularly in the cylinder head, and it is not uncommon to provide different cylinder heads made of different materials and having different compression ratios for use on the same engine block. With any given material, however, the engine has the greatest tendency to knock when it is operating at low speed and under full throttle.

Today most automobiles are operated over well-surfaced roads from which extremely steep grades have been eliminated, and as most modern automobiles are provided with powerful engines, compared with the weight of the automobile, it is unusual for the automobile engine to be operated at low speed and under full throttle and even when so operated the period of such operation is usually brief. However, with present methods and means for supplying combustible mixtures to automobile engines, this relatively rare condition of engine operation limits the compression ratio which can be used in the automobile engine even though a higher compression ratio would be much more desirable for most conditions of engine operation.

An object of my invention is to provide a method of supplying a combustible mixture to an internal combustion engine and a means for carrying out such method whereby the tendency of the engine to knock at low speed full throttle is overcome, thereby permitting the use of higher compression ratio than is now possible and thus increasing the efficiency and power of the engine under normal driving conditions.

Another object is to increase the efficiency of the engine when operating under conditions other than low speed full throttle.

In practically all automobiles now manufactured the engine is located at the forward end of the automobile and the main gasoline tank is located at the rear of the automobile. The fuel feeding systems for such automobiles may incorporate either a fuel lift carburetor or a non-fuel lift carburetor. Where the carburetor of the fuel feeding system is of the non-fuel lift type, the float bowl of the carburetor is maintained under atmospheric pressure and a diaphragm pump, separate "vacuum tank," or other pumping means is provided to pump the gasoline from the main supply tank at the rear of the automobile to the float bowl of the carburetor attached to the engine manifold. Where the fuel feeding system includes a fuel lift carburetor, no diaphragm pump, vacuum tank, or other independent pumping means is necessary.

The fuel feeding system incorporating the fuel lift carburetor is cheaper to manufacture and has other advantages over a fuel feeding system comprising a non-fuel lift carburetor and separate pumping means. Heretofore, however, the fuel feeding system incorporating the fuel lift carburetor has had the disadvantage that it reduced the power of the engine at high speed full throttle and thus reduced the maximum speed which could be obtained by the automobile.

Another object of my invention is to overcome this disadvantage of the prior art fuel feeding systems incorporating fuel lift carburetors.

Another objection to the prior art fuel feeding systems embodying fuel lift carburetors lay in the difficulty of calibrating these fuel feeding systems accurately under conditions of quantity manufacture due to the delicacy of calibration of such prior art fuel feeding systems.

Another object of my invention is to overcome this disadvantage of the prior art fuel feeding systems incorporating fuel lift carburetors.

Another object of my invention is to provide a novel method of supplying fuel to internal combustion engines whereby the efficiency of such engines is increased under normal operating conditions.

Another object of my invention is to provide a fuel feeding system having a novel correlation to the internal combustion engine for the purpose of carrying out the foregoing method.

Another object of my invention is to provide a simpler, less expensive, and more efficient fuel feeding system for modern automobiles.

Another object is to provide an improved fuel lift carburetor.

Another object is to provide an improved carburetor of the non-fuel lift type.

Another object is to provide an improved fuel feeding system having a non-fuel lift carburetor.

Another object is to provide an improved fuel feeding system incorporating a fuel lift carburetor.

Other objects and advantages will become apparent as the description proceeds.

In the drawings,

Figure 1 is a side view of a typical modern automobile, parts being cut away to show the internal combustion engine and the fuel feeding system therefor;

Figure 2 is a sectional view showing part of a fuel feeding system of a type embodying a non-fuel lift carburetor;

Figure 3 is a sectional view of a part of a second type of fuel feeding system embodying a non-fuel lift carburetor;

Figure 4 is a sectional view of part of a fuel feeding system incorporating a fuel lift carburetor;

Figure 5 is an enlarged view of the booster Venturi tube shown in Figure 4;

Figure 6 is a fragmentary view illustrating a modified form of a part of the structure shown in Figure 4; and

Figures 7 and 8 are charts illustrating the operating characteristics of different fuel feeding systems.

Referring to Figure 1 of the drawings, I have illustrated therein a typical modern automobile having an internal combustion engine **12**, located in a suitable enclosed compartment at the forward end of the automobile. The particular engine shown is indicated as being an engine of the type in which the cylinders are located in a straight line, but it is to be understood that my invention is equally applicable to automobiles having engines of the V type or of any other desired arrangement of cylinders.

The automobile engine is illustrated as comprising a cylinder block **14** and cylinder head **16**, both of which may be made of any usual or suitable material. The cylinder block contains a plurality of cylinders **18**, each having a piston **20** connected by means of a connecting rod **22** to the usual engine crank shaft which is not shown. Above each cylinder the cylinder head **16** is provided with a suitable cavity **24** whose volume with respect to the stroke of the piston **20** determines the extent to which the combustible mixture is compressed in the engine cylinder prior to ignition under any condition of operation. In general, it may be stated that an increase in the compression ratio of the engine results in greater power and operating efficiency and, generally speaking, it is desirable to make the compression ratio as high as possible without producing knocking in the engine under any conditions of operation with the fuels now commercially available.

The main gasoline tank from which the engine is supplied with fuel is indicated at **26** and is located at the extreme rear of the automobile. The fuel feeding system for supplying the engine **12** with a combustible mixture of gasoline and air comprises an intake manifold **28** to which a carburetor **30** is shown as being attached. This carburetor **30** is connected with the fuel tank **26** by means of a pipe line consisting of a flexible section **32** which accommodates the rocking movement of the engine on its support on the automobile frame and a relatively rigid portion **34** connecting the flexible portion **32** with the main fuel tank **26**.

Figure 1 discloses my preferred type of fuel feeding system wherein the carburetor **30** is of the fuel lift type and requires no separate pumping means. Portions of the fuel feeding system shown in Figure 1 are shown in greater detail in Figures 4 and 5 and the particular embodiment of my invention shown in Figure 1 will be described in greater detail in a later part of this application.

My novel method of supplying a combustible mixture to an internal combustion engine is not limited to automobile engines, but may be applied to any internal combustion engine operating upon any fuel. This novel method comprises the step of providing a free flow of suitable combustible mixture to the automobile engine, except when the engine is operating at low speed full throttle, and the further step of restricting the flow of combustible mixture to the engine when it is operating at low speed full throttle. By this method the engine operates most efficiently under all conditions of operation. When the engine is operating at high speed full throttle, it receives the maximum quantity of combustible mixture and this is compressed to the maximum degree, thereby producing maximum efficiency and power.

When the engine is operating at low speed full throttle, it receives a smaller charge of combustible mixture than it would receive if the combustible mixture were supplied by the prior art method, that is, without substantial restriction under this condition of operation. The smaller charge received by the engine when my novel method is used would normally tend to reduce the power which it produces. In actual practice, however, I have found that no appreciable reduction in power occurs and in fact an actual increase in power at low speed full throttle is often apparent. This increase in power is due in part to the increased compression ratio whereby the smaller charge taken in is compressed to the same pressure as the larger charge taken in by the prior art engines and in part to the improved atomization of the combustible mixture and improved distribution of this mixture among the several cylinders of the engine which results from the increased vacuum in the intake manifold.

In Figure 2 I have shown one form of fuel feeding system capable of carrying out this novel method. In this figure I have indicated a typical plain tube carburetor **40** having a float bowl **42** supplied with fuel through a pipe **44**. The float bowl communicates with atmosphere through an opening **46** and it will be understood that the pipe **44** leads to a diaphragm pump or other suitable means for lifting fuel into the float bowl **42** from the main fuel tank **26** located at the rear of the automobile.

The float bowl **42** supplies fuel to a nozzle **48** located between a choke valve **50** and the usual throttle valve **52**. The carburetor **40** is of the down-draft type and is attached to the riser **54** of an intake manifold **56** indicated as attached to a cylinder block **58**.

In order to restrict the flow of combustible mixture to the engine cylinders when the engine is operating at low speed full throttle, I have provided the riser **54** with a special valve **60**. This valve is pivotally mounted on a shaft **62** and is urged toward closed position by a weight **64**.

The valve **60** is opened by the flow of combustible mixture from the carburetor to the engine cylinders. When the engine is operating at low speed full throttle, the flow of combustible mixture is relatively small so that the valve **60** is opened to only a slight extent. The lever arm of the weight **64** is a maximum so that valve

60 materially restricts the flow of combustible mixture to the engine cylinders. On the other hand, when the engine is operating at high speed full throttle, the flow of combustible mixture to the engine cylinders is great and the valve 60 is opened to its maximum opening. In this latter position of the valve 60, the lever arm of the weight 64 is a minimum so that the valve 60 has little restrictive effect on the flow of combustible mixture to the engine cylinders.

In Figure 3 I have shown a part of another type of fuel feeding system capable of carrying out my improved method of supplying the fuel to the internal combustion engine. In this type of fuel feeding system there is illustrated a typical air valve carburetor 70 of the non-fuel lift type. This carburetor has a float bowl 72 communicating with atmosphere through an opening 74 and supplied with fuel by means of a pipe 76. It is to be understood that the pipe 76, like the pipe 44 is connected to a diaphragm pump or other similar pumping means which lifts the fuel from the main fuel tank 26 to the carburetor float bowl 72.

The carburetor 70 has a fuel mixture nozzle 78 provided with a primary air inlet 80 and a manual adjustment 82 for regulating the richness of the mixture delivered by the nozzle 78. In addition to the main nozzle 78 this carburetor is provided with an idling jet 84.

The secondary air inlet 86 is provided with the usual choke valve 88. In the normal operation of the engine the admission of secondary air is controlled by the secondary air valve 90 pivoted on a rod 92 and urged toward closed position by a spring 94 whose tension may be adjusted by rotating the sleeve 96.

In order to adapt an air valve carburetor to carry out my novel method, the sleeve 96 is adjusted to produce an unusually high tension on the spring 94 so that the air valve 90 materially restricts the inflow of secondary air and consequently the flow of combustible mixture to the engine when the engine is operating at low speed full throttle. I have provided the secondary air valve 90 with a vane 98 which is most effective to hold the secondary air valve in full open position when the engine demand for combustible mixture is great, as when the engine is operating at high speeds and under full throttle. Under these conditions the secondary air valve offers relatively little resistance to the inflow of secondary air, wherefore the engine receives a maximum charge of combustible mixture. The lower end of the carburetor 70 is provided with the usual throttle valve 100 and is adapted to be attached to the engine inlet manifold indicated at 102. It will be understood that while I have provided the secondary air valve with a vane 98 for rendering its resistance less when the engine is operating under full throttle and at high speeds, means other than the vane 98 may be provided to accomplish this purpose.

In the fuel feeding systems which I have just described in some detail, the carburetors are of the non-fuel lift type and require a separate pumping means to supply them with fuel from the main fuel tank at the rear of the automobile. For use on modern automobiles I prefer a fuel feeding system wherein this separate means is dispensed with and wherein the carburetor is of the fuel lift type. I have illustrated such a fuel feeding system in Figures 1, 4 and 5 of the drawings.

Referring particularly to Figures 4 and 5 I have illustrated the fuel feeding carburetor 30 as having an air inlet 110 of a form suitable for attachment of an air strainer if desired. Part of the air entering the inlet 110 flows through chamber 112 and through fuel feeding nozzle 114 into mixing chamber 116. The lower end of the mixing chamber 116 is provided with the usual throttle valve 118 and is attached to the engine manifold 28.

The nozzle 114 has a restricted throat provided with a step immediately below which are the discharge ends of inclined fuel feeding passages 120 communicating with an annular chamber 122. A duct 124 connects the annular chamber 122 with the upper end of a cylindrical passage 126 whose lower end is located in the float chamber 128. The cylindrical passage 126 is divided by a partition 130 providing a metering orifice in which a metering pin 132 is movably mounted.

The pin 132 is mounted on a guide member 134 reciprocable in the lower end of the cylindrical passage 126 and supported on a bar 136 attached to the lower end of a rod 138 whose upper end is connected by suitable linkage to the throttle valve 118 so that as the throttle valve is opened and closed, the rod 138 and metering pin 132 rise and fall. The upper end of the metering pin 132 is tapered and variably restricts the flow of fuel from the float bowl to the fuel feeding nozzle when the throttle valve 118 is closed or only partly open. When the throttle valve 118 is fully open or nearly so, the smaller portion of the pin 132 below the tapered part thereof is in the metering orifice and permits free flow of fuel from the float bowl to the nozzle.

In addition to the fuel feeding nozzle 114, the carburetor 30 is provided with an idling jet 140 supplied with fuel from the float bowl by way of vertical passage 142, horizontal passage 144, vertical passage 146, and groove 148, in the lower end of rod 138. The groove 148 is so arranged with respect to the lower end of a guide sleeve 150 that when the throttle valve 118 is well opened, communication between the idling jet 140 and the float bowl 128 is cut off.

A small opening 152 connects the mixing chamber 116 with the vertical passage 142 and provides an air supply for the idling jet 140. A very fine hole 154 breaks any siphoning action in the passages leading to the idling jet 140 without supplying any appreciable quantity of air to this idling jet. The idling jet may be adjusted by means of a needle valve 156.

The general arrangement of the idling jet and control therefor which I have just described is described and claimed in my prior application Serial No. 136,544 filed April 13, 1937. This prior application also discloses an accelerator pump which is connected up with and controlled by the throttle valve. Accelerator pumps are commonly used in the fuel feeding systems of modern automobiles and it is to be understood that the carburetor 30 may, if desired, be provided with an accelerator pump like that disclosed in my prior application.

The admission of secondary air to the mixing chamber 116 is regulated by a secondary air valve 160 mounted on a pivoted shaft 162 and urged toward closed position by a weight 164. A pin 166 attached to weight 164 moves in a slot in the rod 168 attached at its upper end to the piston 170 of a dashpot 172. The lower end of the

rod 168 is provided with a tapered portion 174 movable in an orifice 176 for regulating the action of a booster Venturi tube 178.

The purpose of the booster Venturi tube 178 is to maintain sufficient suction in the float bowl 128 to draw fuel thereinto from the main fuel tank 26 located at the rear of the automobile. The suction maintained in the float bowl 128 must always be sufficient to overcome the difference in head between the fuel in the main tank 26 and the inlet 180 to the carburetor float bowl. This difference in head varies with the level of the fuel in the fuel tank 26 and also with the grade of the road over which the automobile is traveling. For practical purposes this difference in head must be figured as the maximum difference in head between the inlet 180 and the surface of the fuel in the main tank 26 when this tank is practically empty and when the automobile is traveling up the maximum grade for which it is designed to operate. In addition to overcoming this difference in head, the suction existing in the carburetor float bowl must at any time be sufficient to overcome the frictional and inertia losses in the pipe line between the float bowl and main tank under the conditions of flow then existing.

One of the principal difficulties with prior art fuel feeding systems incorporating fuel lift carburetors has lain in the fact that the float bowl suction for high speed engine operation was necessarily so great that the differential in pressure between the float bowl and the throat of the main fuel feeding nozzle was too slight to permit proper regulation of the fuel supply to the nozzle for the purpose of proper carburetor calibration. The very small difference in pressure between the float bowl and the fuel supply nozzle made the regulation of fuel supplied to the nozzle so delicate that extreme accuracy was necessary in the manufacture and assembly of the carburetor, wherefore the carburetor was ill-adapted for manufacture by large production methods.

In the chart of Figure 8 I have graphically illustrated this difference in pressure. Curve 1 on this chart shows the difference in pressure between the float bowl and the fuel feeding nozzle of a plain tube carburetor for different engine speeds when the engine is operating at full throttle. In such a carburetor the float bowl is usually maintained under approximately atmospheric pressure. From this curve it is apparent that when the engine is operating at low speed full throttle, there is only a small difference in pressure between the float bowl and the fuel feeding nozzle, whereas when the engine is operating at full speed full throttle, this difference in pressure rises to approximately 58 inches of gasoline in the typical installation upon which this chart is based.

Curve 2 of this chart represent the difference in pressure between the float bowl and fuel feeding nozzle of a fuel feeding system having a fuel lift carburetor and involving every refinement known prior to my present invention. From this curve 2 it is apparent that when the engine is operating at low speed full throttle, the difference in pressure between the float bowl and the fuel feeding nozzle is on the order of two to three inches and that this difference in pressure never rises above eight or nine inches of gasoline even when the engine is operating at full speed. Since the difference in pressure between the nozzle and the float bowl must be relied upon to draw fuel from the float bowl to the nozzle, and must also be relied upon as affording the means for regulating the fuel delivery to the nozzle under different conditions of engine operation, it will be apparent that the calibration of such a fuel feeding system is extremely delicate and unsuited for large production manufacture.

An important object of my present invention is to overcome this difficulty with prior fuel feeding systems utilizing fuel lift carburetors without decreasing the volumetric efficiency of the engine when operating full speed full throttle. I accomplish this new result by changing the connections between the float bowl of the carburetor and the main fuel tank 26. As a first step in this direction I have enlarged and redesigned the inlet valve 182 controlled by float 184 in such a manner as to provide a freer and less restricted flow of fuel into the float bowl of the carburetor. As a second step I have enlarged and redesigned the strainer 186 and its associated chamber 188 to offer less restriction to the flow of fuel therethrough. As a third step I utilize a larger diameter of flexible tubing 32 and relatively rigid conduit 34 and arrange this tubing and conduit to eliminate sharp bends in so far as this is possible. I have discovered that these changes make it possible materially to reduce the degree of suction in the carburetor float bowl when the engine is operating at full speed full throttle.

I may cite as a typical example the difference in operation between a fuel feeding system incorporating a fuel lift carburetor of the type disclosed and claimed in my said prior application and an improved fuel feeding system incorporating an improved fuel lift carburetor embodying the invention disclosed in the instant application when both of these fuel feeding systems were tested on a standard Ford V-8 automobile. In such prior fuel feeding system it was necessary to maintain a suction of 42 inches of gasoline in the carburetor float bowl when the engine was idling to overcome the 24 inch difference in static head between the carburetor and the fuel tank and allowing 18 inches of gasoline to overcome additional difference in head due to a maximum road grade of 15%.

With this fuel feeding system it was necessary to increase the suction in the float bowl to sixty-six inches of gasoline when the engine was operating at full speed full throttle in order to provide for the thirty-three inch head of gasoline which was required to overcome the friction and inertia losses in drawing fuel at the required rate from the main fuel tank to the carburetor float bowl. Even by increasing the vacuum in the float bowl to sixty-six inches of gasoline, only nine inches of gasoline was available to overcome additional differences in level between the float bowl and the gasoline in the main fuel tank resulting from road grades. This nine inches of gasoline is equivalent to the additional difference in head resulting from a road grade of 7½%.

The differences in pressure between the nozzle and the float bowl of this fuel feeding system are best illustrated by curve No. 2 in Figure 8. Even when the engine was operating at full speed full throttle, the differential in pressure between the nozzle and the float bowl was only 7.8 inches of gasoline. In order to obtain even this small difference in head, it was necessary to unduly restrict the flow of air to the engine manifold at full speed full throttle. The result of this undue restriction was a loss in engine power at full speed full throttle.

Referring to Figure 7, curve 1 of the chart represents the manifold vacuum in inches of gasoline when the engine is operating at different speeds and at full throttle where the engine is equipped with a typical plain tube carburetor. Curve 2 of Figure 7 shows the corresponding manifold vacuum when the engine is equipped with a fuel feeding system having a fuel lift carburetor like that of my said prior application. By comparing curves 1 and 2, it will be seen that when the engine is operating at full speed full throttle, the manifold vacuum was approximately five inches of gasoline less when the engine was equipped with the plain tube carburetor. The additional five inches of manifold backing obtaining at full speed full throttle when the engine was equipped with my prior fuel lift carburetor resulted in a noticeable loss in power and maximum speed as compared with the power and maximum speed developed by the same engine when equipped with a plain tube carburetor. This fact reduced the commercial possibilities of my prior carburetor.

As a result of elaborate tests, I have discovered that in the fuel feeding system incorporating my prior fuel lift carburetor, the restrictions to the flow of fuel from the main fuel supply tank to the float bowl of the carburetor when the engine was operating at full speed full throttle, were as indicated in the following chart. By a drastic change in that part of the fuel feeding system connecting the carburetor float bowl with the main fuel tank, it was possible to reduce the total resistance to approximately one-third. These drastic changes included increasing the size of the copper tubing from one-fourth of an inch O. D. to five-sixteenths of an inch O. D., materially increasing the size of the flexible tube, redesigning the strainer to secure freer passage of gasoline, and redesigning the float valve to secure freer passage of gasoline. The corresponding resistances for this drastically changed fuel feeding system are also shown in this table:

Fuel feeding system of prior application		Improved fuel feeding system of this application
The ¼" copper tube leading from the rear tank to the flexible tube attached to the carburetor float bowl	20" of gasoline	6" of gasoline
The flexible tube which is inserted between the end of the copper tube and the carburetor	5" of gasoline	2" of gasoline
The strainer of the carburetor	3" of gasoline	2" of gasoline
The float valve	5" of gasoline	2" of gasoline
Total	33" of gasoline	12" of gasoline

In the improved fuel feeding system of my present application, the suction in the float bowl of the carburetor can thus be reduced from sixty-six inches of gasoline at full speed full throttle to only forty-five inches of gasoline. This would give an increased differential between the nozzle and float bowl at full speed full throttle from 7.8 inches to 28.8 inches of gasoline. All of this additional difference in head between the float bowl and fuel feeding nozzle could be utilized for purposes of calibration. Because of the greatly increased difference in head between the nozzle and the float bowl, it would be necessary to provide a small restricting orifice between the nozzle and the float bowl in order to prevent the nozzle from drawing too great a volume of fuel due to this increased difference in head.

For practical purposes, however, it is not necessary to have all of this additional difference in head between the fuel feeding nozzle and the float bowl in order to reduce the sensitivity of the carburetor sufficiently so that it can be made by large production manufacture. Instead, therefore, of utilizing all of this gain for the purpose of increasing the pressure differential between the fuel feeding nozzle and the float bowl, I prefer to use only a part of the increased pressure differential for this purpose and to avail myself of the rest of the advantage thus gained to increase the power output of the automobile engine by reducing the restricting effect of the secondary air valve.

In Figures 4 and 5 of this application I have shown a fuel feeding system having the improved and less restrictive float valve **180**, **182**, the improved strainer and strainer chamber **186** and **188**, the enlarged flexible tube **32** and the enlarged copper tube **34**. The carburetor forming part of this fuel feeding system of Figures 4 and 5 is designed to make the most desirable use of the reduction in float bowl suction made possible by the improved fuel feeding connections between the float bowl and the main fuel tank **26**.

In the carburetor of Figure 4 the nozzle **114** is made of reduced size as compared with the nozzle shown in my said prior application. While Figure 4 of the instant application shows only a single nozzle **114** and a single mixing chamber **116**, it is to be understood that the carburetor shown in this figure may be of the dual type like that shown in my said prior application and in fact both carburetors used in the tests on the Ford V-8 automobile were of the dual type, the nozzles and mixing chambers being arranged generally as shown in my said prior application. The smaller nozzles of the carburetor shown in Figure 4 of the instant application are made possible by the reduction in the float bowl suction which in this carburetor is only forty-five inches of gasoline at full speed full throttle, there being provided a maximum difference in pressure between the nozzles and the float bowl of approximately twenty-three inches at full speed full throttle as illustrated by curve 3 in Figure 8, which shows the difference in pressure between the nozzle and float bowl of my improved carburetor for all engine speeds at full throttle.

The use of the smaller nozzles **114** has several important advantages. In the first place it provides better idling operation of the automobile engine in that less air is drawn into the mixing chambers through the nozzles when the secondary air valve **160** is closed. These smaller nozzles are also less sensitive to manufacturing variations in the sizes of the various parts of the carburetor and thus made possible larger commercial tolerances in the manufacture of these parts.

The booster Venturi tube **178** is provided for the purpose of maintaining the proper degree of suction in the float bowl **128** under all conditions of operation. This booster is supplied with atmospheric air through an inlet **200** from whence the air passes through opening **202** in choke plate **204** into the interior of a metal cup **206** held in place by stud **208** and spring **210**. The air passes from the interior of the cup **206** into the booster **178** through a second opening **212** in the choke plate **204**. It will be understood that the choke plate **204** may be rotated on

the stud 208 by a manual control accessible to the operator of the vehicle for temporarily reducing the effectiveness of the booster 178 and thereby increasing the richness of the mixture supplied by the nozzle 114 to provide easier starting when the engine is cold.

The booster 178 is shown in greater detail in Figure 5. This booster has a restricted throat provided with a step 214 which is materially larger than the step of the booster in my said prior application. Just beyond the step 214 are radial passages 216 leading to an annular space 218 communicating with the float bowl of the carburetor through duct 220. The larger step 214 renders the booster 178 less efficient to create suction in the carburetor float bowl under normal operating conditions, but this larger step materially increases the ability of the booster 178 to withdraw large quantities of vapor from the float bowl whenever the gas in the float bowl is heated to such an extent as to give off large quantities of vapor.

The ability to use effectively a booster having a larger step in its throat is an important advantage of my present invention. It is only possible to use such a booster because of the increased suction obtaining in the mixing chambers 116 under idling conditions resulting from the smaller nozzles 114 which admit less air to the mixing chambers when the secondary air valve 160 is closed. The larger nozzles used in the carburetor of my said prior application admit so much air to the mixing chambers when the engine is idling that a booster having a smaller step and capable of creating a higher degree of suction in the float bowl with less flow through the booster is essential to the proper operation of the carburetor of my said prior application.

An important feature of the carburetor shown in Figure 4 lies in the increased size of the secondary air valve 160, whereby this air valve offers less restriction to the flow of air into the mixing chamber 116 when the engine is operating at full speed full throttle. This in turn reduces the manifold vacuum at high engine speeds and increases the power of the engine under such conditions of operation. In the chart, Figure 7, the manifold vacuum of an engine having the improved fuel feeding system shown in Figure 4, is indicated by curve 3. This curve shows that at full speed full throttle the manifold vacuum is slightly less than the manifold vacuum in a corresponding engine equipped with an ordinary plain tube carburetor wherein the manifold vacuum is represented by curve 1. An automobile equipped with my improved fuel feeding system of Figure 4 thus develops greater power and speed when the engine is operating at full speed full throttle than does a similar automobile having a conventional plain tube carburetor of the most improved type. My improved fuel feeding system of Figure 4 thus overcomes one of the greatest disadvantages of prior fuel feeding systems having fuel lift carburetors.

The enlarged secondary air valve 160 and freer flow of air permitted thereby reduces the suction created by the nozzles 114. Whereas, in the carburetor of my said prior application the nozzles developed a suction of 73.8 inches of gasoline when the engine was operating at full speed full throttle, the nozzles of my improved carburetor of Figure 4 develop only a suction equivalent to 68 inches of gasoline under the same conditions. This leaves a pressure differential between the nozzles and float bowl of approximately 23 inches of gasoline when the engine is operating at full speed full throttle as indicated by curve 3 in Figure 8. This pressure differential is ample for the calibration of carburetors made by large production methods.

Thus far I have illustrated and described an improved fuel feeding system using an improved fuel lift carburetor which has many advantages over anything known to the prior art. The reduction in the float bowl suction which I have obtained by improving the connection between this float bowl and the main fuel supply tank located at the rear of the automobile, makes it possible to provide a fuel lift carburetor which operates on an entirely different principle from the carburetor shown in Figures 4 and 5. In Figure 6 I have illustrated a modification of the carburetor shown in Figures 4 and 5. I shall now describe the modified carburetor of Figure 6 and its new principle of operation.

In the carburetor of Figures 4 and 5 the booster Venturi tube 178 is relied upon to produce a suction in the float bowl 128. In the modified carburetor of Figure 6 the booster 178 no longer performs this function. The main fuel supply nozzles are relied upon to produce the suction in the float bowl and the booster 178 acts solely as a means to limit the degree of suction created in the float bowl by the fuel feeding nozzles.

It is to be understood that the modified form of carburetor which is partially shown in Figure 6 is identical with the carburetor of Figures 4 and 5, except in the respects which I shall now point out. In this carburetor of Figure 6 it will be understood that the fuel feeding nozzles corresponding to the nozzles 114 of Figure 4 are large nozzles of a size like that of the carburetor of my said prior application instead of being the smaller nozzles 114 of Figure 4. I have previously pointed out that where such larger nozzles are used with my improved fuel supply line and reduced float bowl suction, it is essential to provide an additional restriction between the float bowl and the nozzles and in Figure 6 I have illustrated such a restriction. In this figure the cylindrical passage 126 which projects downwardly into the float bowl 128 is provided with the usual metered orifice 130 in which there is located a metering pin 132*a*. This metering pin is mounted on a guide 134*a* having a restricted passage 250 communicating with the float bowl 128.

In the wall of the cylindrical passage 126 I have provided three small openings 252 for the purpose of removing vapor from the upper part of the float bowl 128. The upper one of these openings 252 is always above the fuel level in the float bowl as is clearly indicated in Figure 6, whereas the other two of these openings are sometimes above the fuel level in this float bowl and sometimes below this level, as the level of the fuel varies, the lower level being indicated by the dot-and-dash line of Figure 6.

In the operation of the carburetor of Figure 6, the main fuel feeding nozzles create a suction in the cylindrical passage 126 sufficient to raise fuel from the float bowl 128 through the restriction 250, the metering orifice 130 and passages 126 and 124 to the nozzle throats. The restriction 250 maintains a pressure differential between the float bowl 128 and the passage 126 which is effective to draw vapor thereinto through the openings 252. These openings are so small that

when the lower openings are immersed in liquid, there is no appreciable liquid flow therethrough. The flow of vapor through the openings **252** removes vapor from the upper part of the float bowl **128**.

The modified form of the invention shown in Fig. 6 is particularly desirable for hot weather operation, wherein the carburetor float bowl is heated sufficiently to create a considerable amount of vaporization of the fuel contained therein. Under this type of operation, all of the vapor created in the float bowl is drawn through the openings **252**, orifice **130**, and passages **126** and **124** to the nozzle Venturi tubes where it is mixed with air discharged into the mixing chamber. The capacity of the nozzle Venturi tube to withdraw vapor from the float bowl is, of course, much greater than the capacity of the ordinary booster Venturi tube to withdraw such vapor, so that with the arrangement of Fig. 6 there is no possibility that in hot weather the vaporization of the fuel in the float bowl will interfere with the creation of sufficient suction in the float bowl to draw liquid fuel thereinto from the main fuel supply tank located at the rear of the automobile.

The modification of Fig. 6 has a further advantage, in that the vapor existing in the float bowl is drawn into the nozzle Venturi tubes where it is mixed with air and ultimately forms a combustible mixture which creates power in the engine cylinders. In prior carburetors, the vapor from the float bowl has been withdrawn by way of the booster Venturi tube, and while the vapor so withdrawn ultimately reaches the engine cylinders, it is supplied to the cylinders as excess fuel and is thus wasted from a power standpoint. In fact, with the prior arrangement, the vapor withdrawn from the float bowl is worse than wasted, in that it tends to over enrich the mixture supplied to the cylinders and thus contributes to the production of excess carbon in these cylinders.

While the nozzle Venturi tubes are withdrawing relatively large quantities of vapor from the float bowl, these nozzle Venturi tubes are withdrawing a slightly decreased quantity of liquid fuel from the float bowl, so that under these conditions there is a slight decrease in the total quantity of fuel supplied to the engine cylinders. This in turn results in superior engine operation, since the slight decrease in fuel supplied compensates for the increase in engine temperature, as a hot engine requires less fuel than a cold engine.

While my novel fuel feeding systems are primarily intended to be incorporated at the factory in new automobiles and similar mechanisms, my invention may readily be applied to existing automobiles and other like mechanisms. If the existing automobile is provided with a plain tube carburetor similar to the carburetor **40** shown in Fig. 2, the efficiency and maximum power developed by the automobile engine can be increased by removing the regular cylinder head and substituting therefor a higher compression cylinder head. The high compression head should be so selected that it provides the maximum compression which can be used without knocking when the engine is operating at full speed, full throttle, with the desired fuel.

In order to make the automobile operate properly at low speed full throttle, it will be necessary to provide means such as the valve mechanism **60**, **62**, and **64** of Fig. 2 in order to raise the manifold vacuum sufficiently at low speed full throttle to prevent knocking under this condition of operation.

Referring to the chart, Fig. 7, it will be noted that this chart contains a series of short vertical lines indicating the area in which knocking will occur when the engine is operated at low speed full throttle when used with a high compression head of the kind which I contemplate using. From this chart it will be noted that the curve numbered **1** which represents the manifold vacuum in the intake manifold of an engine equipped with a plain tube carburetor, passes through this area of knocking. The function of the valve means **60**, **62**, **64** is to increase the manifold vacuum at low speeds so that the corresponding curve would be raised above the area in which knocking occurs.

The curve numbered **3**, which represents the manifold vacuum under different conditions of operation of an engine equipped with a fuel lift carburetor, like either Fig. 4 or Fig. 6, is an example of a curve which avoids this area of knocking and which makes possible the use of the high compression head which I contemplate. The fuel feeding system of Fig. 2 comprising the plain tube carburetor with the valve for maintaining high manifold suction at low engine speeds, would approximate the curve numbered **3** in the chart of Fig. 7.

In a somewhat similar manner, an existing automobile equipped with an air valve carburetor generally similar to that shown in Fig. 3, could be modified to give increased efficiency and power by using a higher compression head and modifying the operation of the valve mechanism of the air valve carburetor to increase the manifold vacuum at low engine speeds. In lieu of changing the valve mechanism of the air valve carburetor, the same result could be accomplished by using an additional valve similar to the valve **60**, **62**, **64** of Fig. 2.

In an existing automobile provided with a fuel lift carburetor, increased power and efficiency could be obtained by substituting a higher compression head and by removing the carburetor and fuel line supplied with the automobile and substituting therefor a carburetor and fuel line like that of Fig. 4 or Fig. 6.

It is to be understood that my invention is not limited to the details shown and described, but may assume numerous forms, and that the scope of my invention is limited solely by the following claim.

I claim:

An internal combustion engine comprising a cylinder, a high compression head therefor, a piston reciprocable in said cylinder, means driven by said piston, a manifold for supplying a combustible mixture to said cylinder, a throttle valve controlling the quantity of combustible mixture supplied to said cylinder, and fuel feeding means including said throttle valve for maintaining a suction of between 25 and 60 inches of gasoline in said manifold for all conditions of engine operation when said valve is fully opened, said last-named means comprising a mixing chamber in which said valve is located, a nozzle for supplying fuel to said mixing chamber, a float bowl constituting a source of fuel supply for said nozzle, a passage connecting said nozzle with said float bowl, means for reducing the weight of a column of fuel in said passage and consisting of a series of vertically spaced orifices connecting the upper part of said float bowl with said pas-

sage and including orifices located both above and below the normal level of fuel in said float bowl, a restriction in said passage below said orifices, a booster Venturi tube discharging into said mixing chamber, a passage connecting the throat of said Venturi tube with said float bowl, an air valve for admitting air to said mixing chamber, and a weight variably urging said valve toward closed position, said weight exerting greater force on said valve and thereby maintaining a higher degree of suction in said manifold when said engine is operating at low speed full throttle than when said engine is operating at high speed full throttle whereby the tendency of said engine to knock at low speeds is reduced.

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