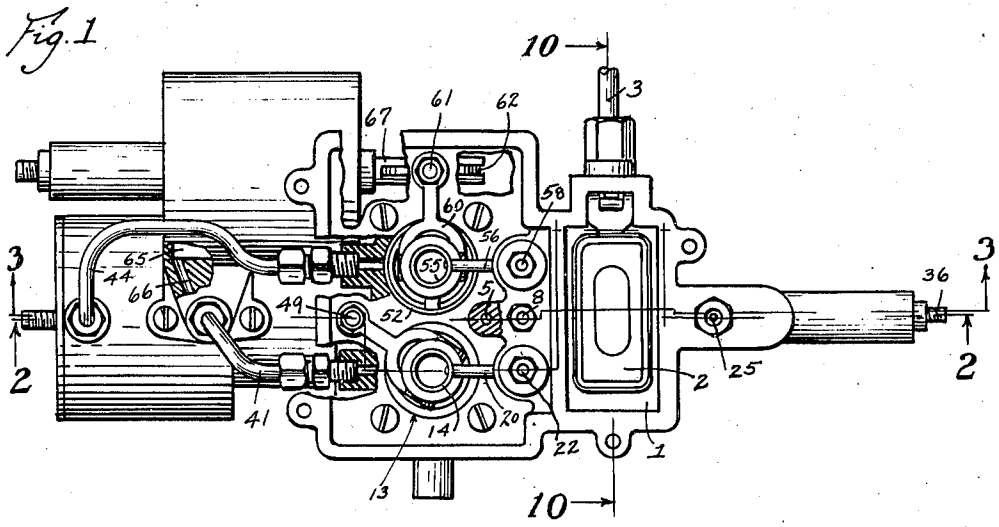
Aug. 24, 1943. A. E. CHISHOLM 2,327,592

CARBURETOR

Filed April 8, 1940 6 Sheets-Sheet 1

Fig. 1



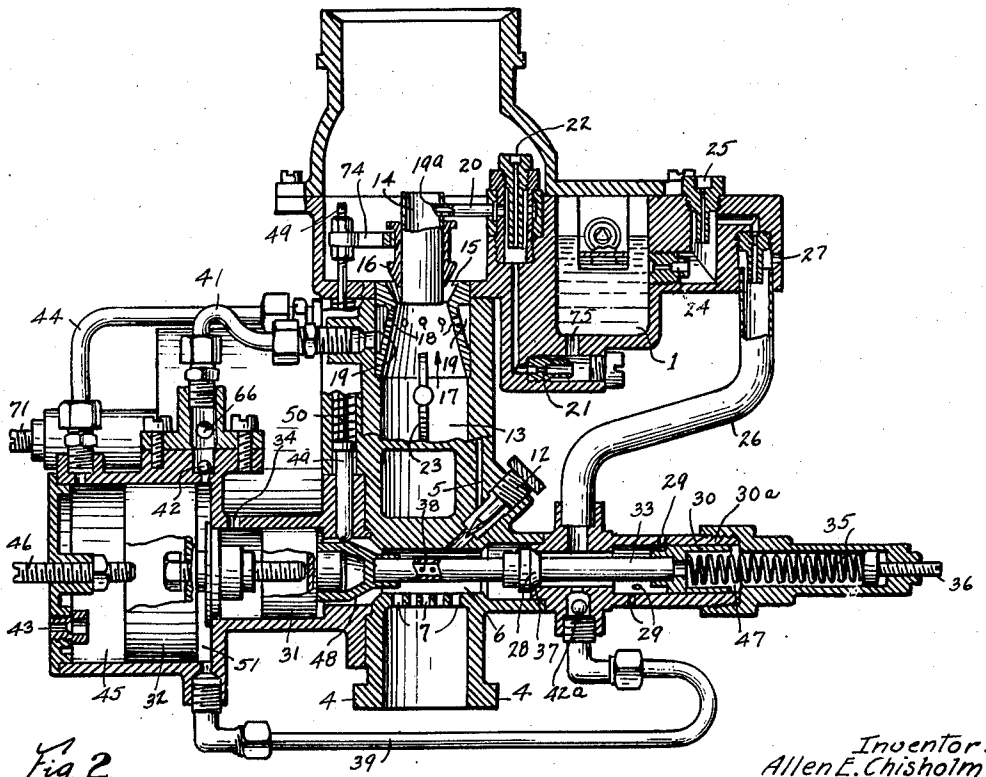


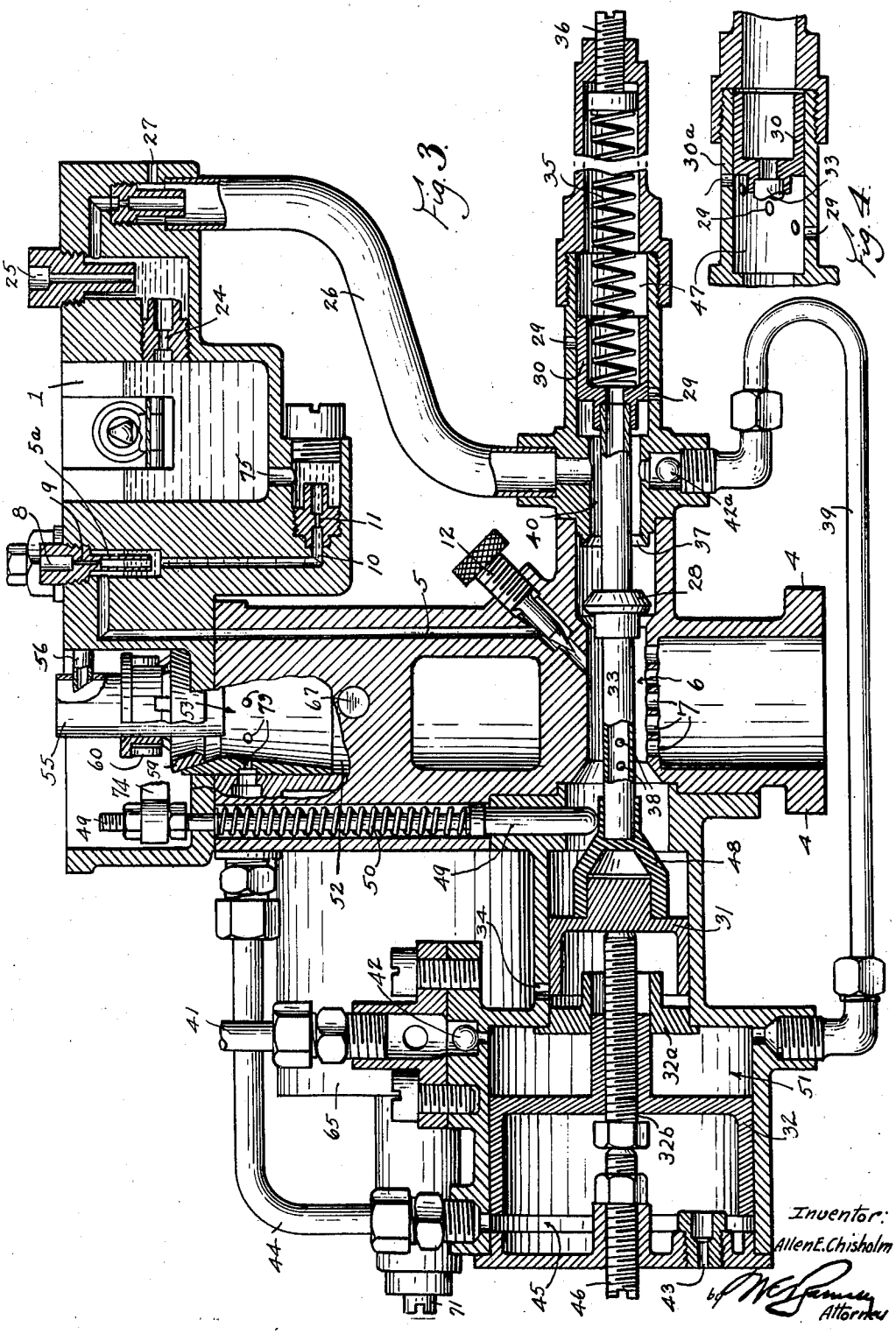
Fig. 2.

Inventor:
Allen E. Chisholm
by [signature]
Attorney.

Aug. 24, 1943. A. E. CHISHOLM 2,327,592

CARBURETOR

Filed April 8, 1940 6 Sheets-Sheet 2



Aug. 24, 1943. A. E. CHISHOLM 2,327,592

CARBURETOR

Filed April 8, 1940 6 Sheets-Sheet 3

Fig. 5.

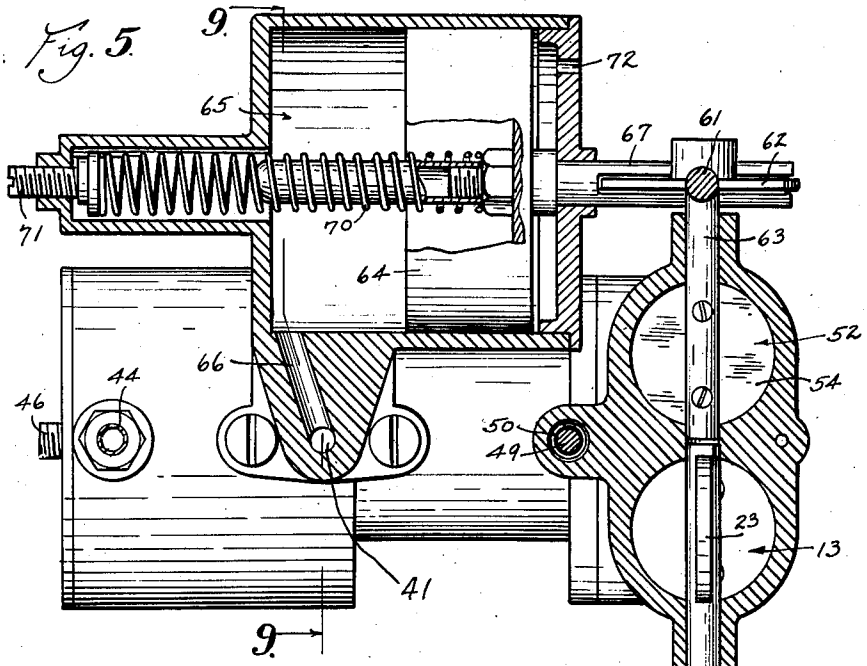
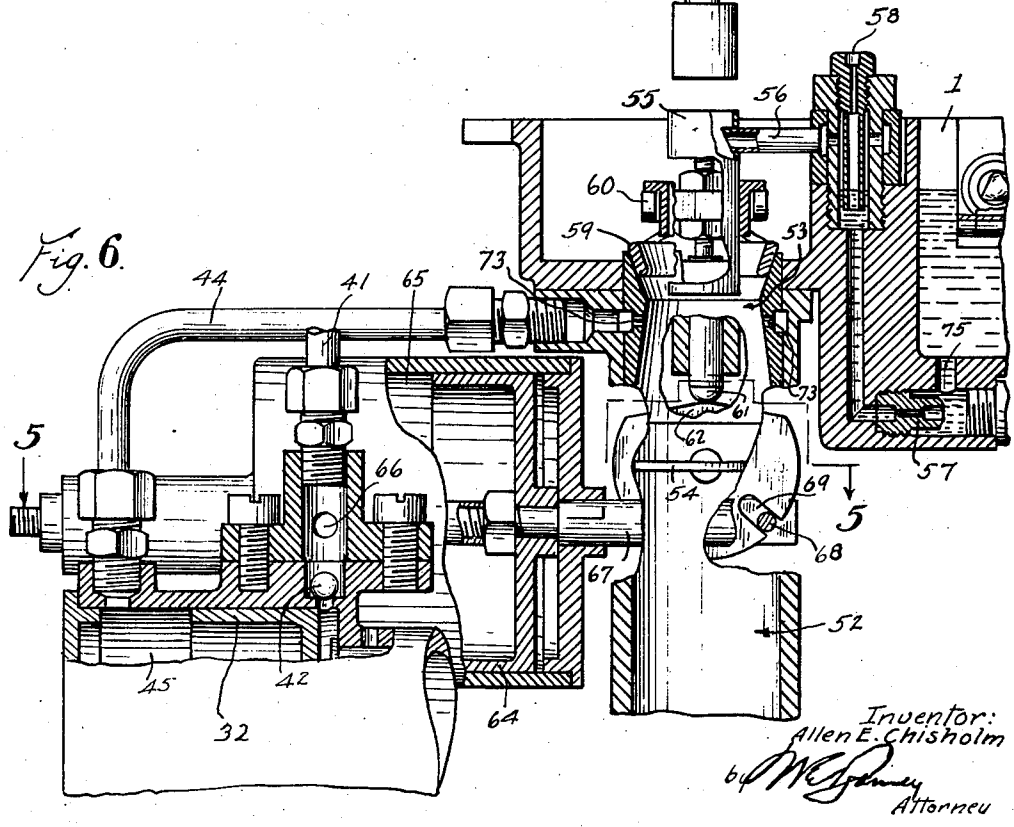


Fig. 6.



Inventor:
Allen E. Chisholm
By W. C. Spruance
Attorney

Aug. 24, 1943. A. E. CHISHOLM 2,327,592

CARBURETOR

Filed April 8, 1940 6 Sheets-Sheet 4

Fig. 7.

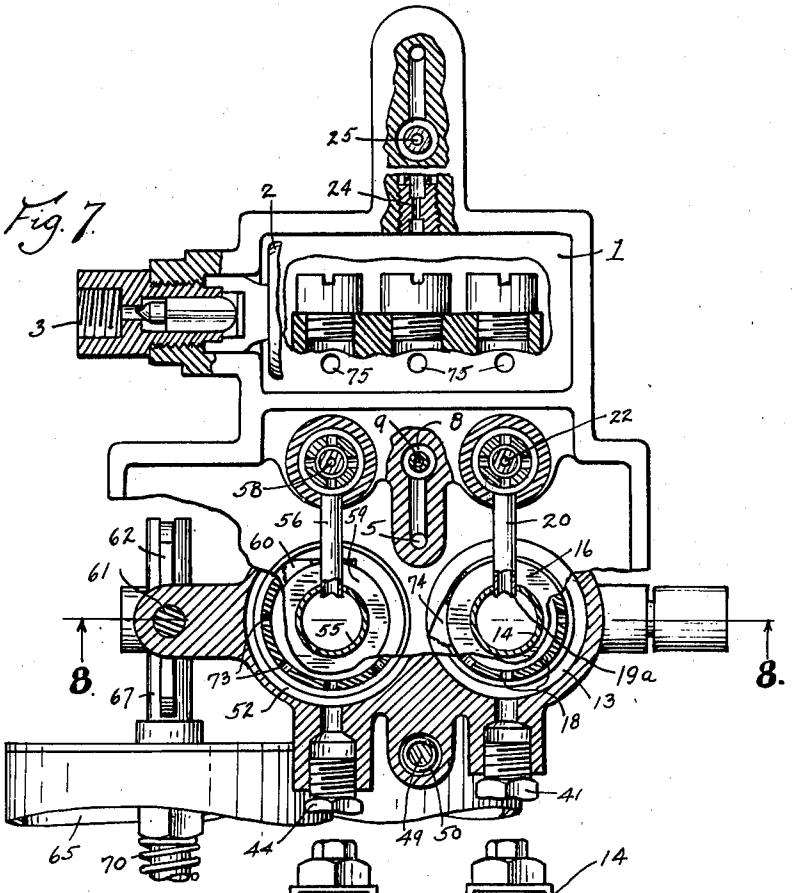
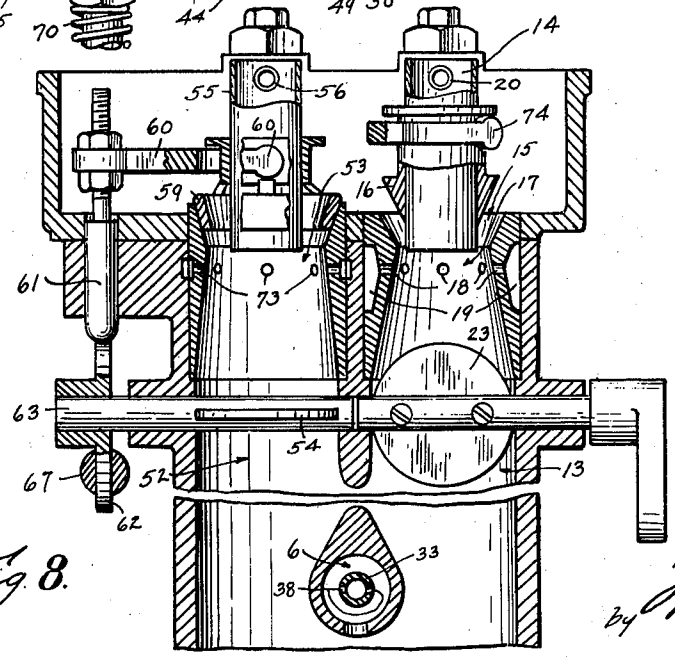


Fig. 8.



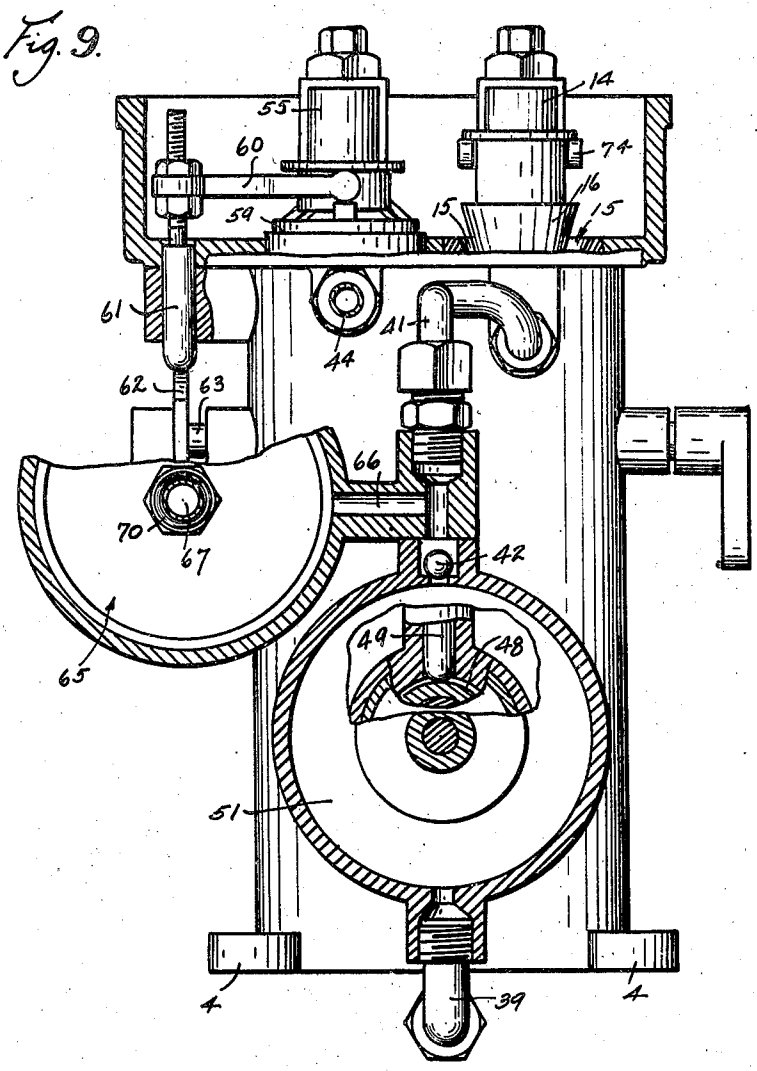
Inventor:
Allen E. Chisholm
By M. E. Sommers
Attorney

Aug. 24, 1943. A. E. CHISHOLM 2,327,592

CARBURETOR

Filed April 8, 1940 6 Sheets-Sheet 5

Fig. 9.



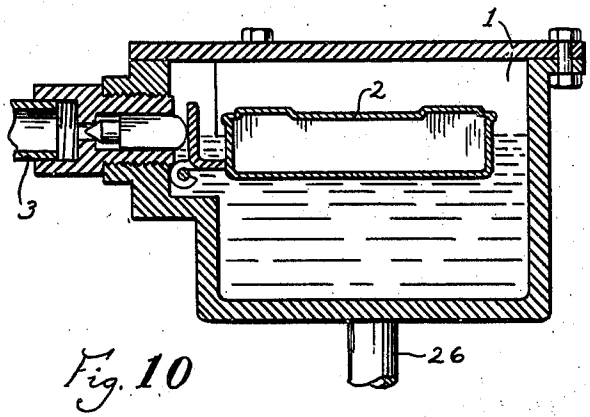


Fig. 10

Inventor:
Allen E. Chisholm
by M. C. Penney
Attorney.

Aug. 24, 1943. A. E. CHISHOLM 2,327,592

CARBURETOR

Filed April 8, 1940 6 Sheets-Sheet 6

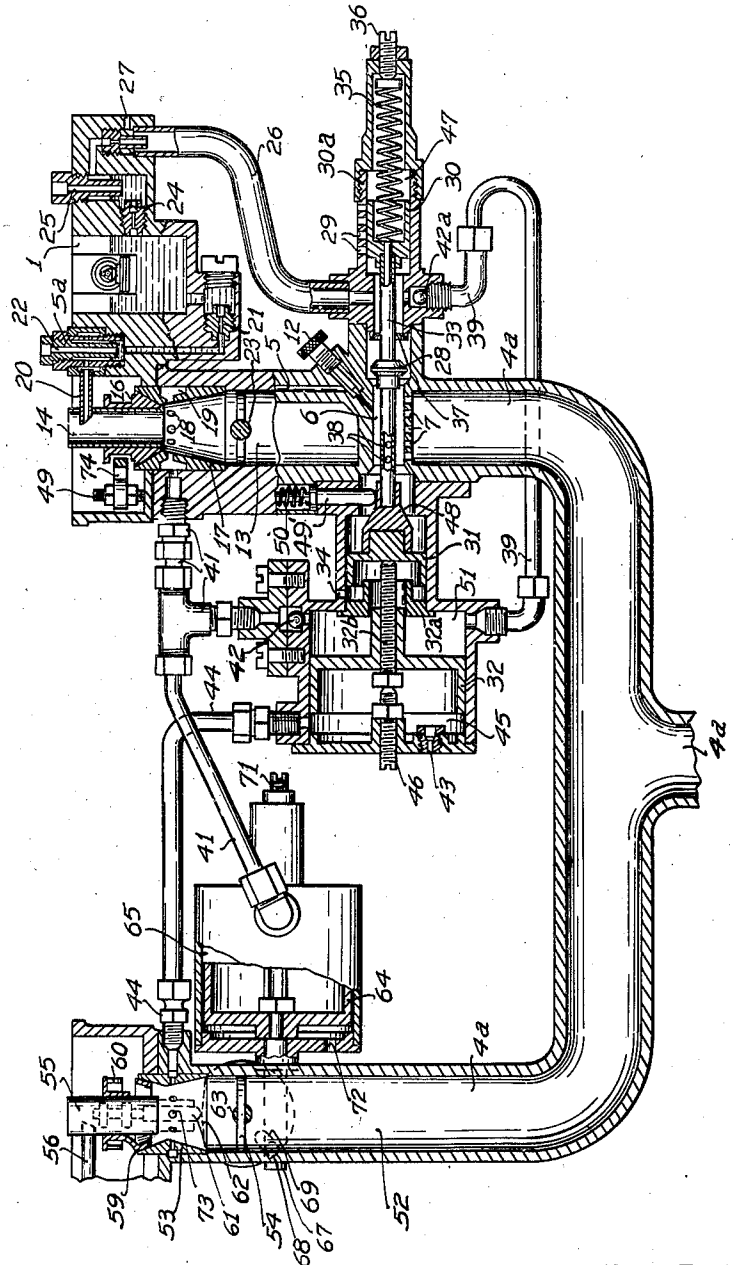


Fig. 11

INVENTOR

Allen E. Chisholm

BY

ATTORNEY

Patented Aug. 24, 1943 2,327,592

UNITED STATES PATENT OFFICE

2,327,592

CARBURETOR

Allen E. Chisholm, Portland, Oreg.

Application April 8, 1940, Serial No. 328,449

9 Claims. (Cl. 261—23)

My invention relates to carburetors for internal combustion engines, and it is particularly adapted for use with engines whose operating speeds and loads vary frequently thereby imposing upon said carburetors varying demands as to the quantity of fuel mixture required, and also as to the quality of said mixture. For convenience, I will describe my invention in connection with automobile engines adapted to burn gasoline, this being a typical use for said invention.

Automobile carburetors of the "down draft" type have heretofore been used wherein a cylindrical conduit leading to the intake manifold of the engine has been provided with a so-called venturi, or constriction, adapted to produce a high velocity and low pressure of the air passing therethrough. Said high air velocity is desirable for reasons hereinafter discussed. A difficulty immediately arose, however, in that a venturi of suitable size to give the desired high velocity at low engine speeds would unduly restrict the flow of air to the engine at higher engine speeds. To meet the aforesaid difficulty, it has been proposed to provide two cylindrical conduits leading to the intake manifold of the engine, each provided with a venturi, one to function alone at low engine speeds and the other to become also operative at higher engine speeds.

This arrangement has not been wholly satisfactory, however, because the control means by which the aforesaid supplemental venturi has been made operative has not functioned to supply the required quantity and quality of fuel mixture to the engine at the various speeds and loads thereof. Generally speaking, the requirements of an automobile engine are for an enriched fuel mixture for starting, for accelerating, for pulling heavy loads, and for attaining the maximum speed of which said engine is capable under load. Otherwise, a lean mixture is preferable to save fuel and to minimize the deposition of carbon within the engine.

A further difficulty that has been encountered with carburetors heretofore known is due to the requirements of an engine of an enriched fuel mixture for accelerating. An attempt has been made to meet said difficulty by providing means for introducing a small quantity of liquid fuel into the air stream entering the carburetor each time the manually operated accelerator is actuated. This expedient has been objectionable in that said liquid fuel has not been readily vaporized, and also in that the same quantity of liquid fuel has been supplied when the engine load was light and when it was heavy, whereas the requirement has been for a larger amount of additional fuel for accelerating under heavy load as compared to the amount required under light load.

The principal object of my invention is to provide a carburetor that will automatically supply an engine with the proper quantity and quality of air-fuel mixture under all operating conditions of said engine as to speed and load. I achieve said result, broadly speaking, by providing a carburetor comprising four more or less separate air-fuel passageways, each adapted to perform a special function, and by providing means for correlating the operation of said air-fuel passageways to bring about the desired over-all result.

More specifically, I provide a primary carbureting chamber having a manually controllable throttle valve of the ordinary type. I so proportion said primary carbureting chamber and the venturi therein, according to well known design data, that it will supply the proper amount of air-fuel mixture to the engine when the latter is operating at a moderate speed of, say, 35 miles per hour. At higher speeds, said primary carbureting chamber would supply an insufficient quantity of air-fuel mixture to said engine to assure efficient and effective operation thereof; so I provide a secondary carbureting chamber to become operative at speeds above 35 miles per hour as hereinafter described.

At speeds below 35 miles per hour, the aforesaid primary carbureting chamber will supply the engine with an air-fuel mixture that is too lean for effective operation thereof under certain conditions, such, for example, as rapid acceleration or pulling heavy loads; so I provide an auxiliary air-fuel passageway for enriching said air-fuel mixture automatically the proper amount when the manual throttle valve is opened. The required enrichment of said air-fuel mixture for accelerating differs at different engine speeds, more enrichment being required at slow speeds and little or none at the assumed optimum speed of 35 miles per hour, this being the speed at which the primary carbureting chamber is assumed to be designed to function properly by itself. Lastly, I provide an idling air-fuel passageway of a well known type, differing from other idling devices, however, in that, in the form which I prefer, said idling air-fuel passageway is adapted to supply all of the air-fuel mixture for the engine during idling,

whereas it is necessary to open the main throttle of other carburetors a slight amount during idling.

From the foregoing statements, it should not be inferred that the sole function of the so-called auxiliary air-fuel passageway which forms a part of my invention, is to provide an enriched air-fuel mixture for accelerating; it also provides an enriched mixture for starting, for pulling heavy loads at any speeds, and for attaining maximum speed. On the other hand, the action of said auxiliary air-fuel passageway is enhanced by the action of a choke engaging the venturi of the primary carbureting chamber, said choke and the control valve of said auxiliary air-fuel passageway being mechanically interlocked so that, whenever said control valve opens to admit a rich mixture from the auxiliary air-fuel passageway to the intake manifold of the engine, said choke will also operate to enrich the mixture passing from the primary carbureting chamber to said manifold by a choking action hereinafter described.

An important feature of my invention is the manner in which the various parts thereof co-operate to achieve uniform operation of the engine at all speeds and loads. For example, an automobile engine employing my invention may be started in the ordinary way, the accelerating air-fuel passageway co-operating with the idling air-fuel passageway to give an enriched starting mixture. Then, after the engine has started, the accelerating air-fuel passageway will gradually become wholly inoperative, if the engine is warm, and the idling air-fuel passageway alone will supply said engine. However, if the engine is cold, or if for any other reason it tends to stop, said accelerating air-fuel passageway will be brought into use to give an enriched mixture whenever the engine slows down. Furthermore, the aforesaid enrichment of the fuel mixture of the accelerating air-fuel passageway when the engine slows down will take place so quickly that there is little danger of the engine stopping due to a too lean mixture. Therefore, the idling air-fuel passageway may be adjusted to give a lean mixture and low idling speed.

When it is desired to put the automobile in motion, it is, of course, necessary to supply more fuel mixture to the engine, and it is desirable that said fuel mixture should be enriched, as compared to the idling fuel mixture. In my invention, by means hereinafter described, the auxiliary air-fuel passageway is automatically brought into use when the manual throttle is opened, thereby enriching the fuel mixture for starting the automobile. Thereafter, as the automobile gains speed, said auxiliary air-fuel passageway gradually becomes inoperative and the primary carbureting chamber supplies the engine with the proper fuel mixture, the idling air-fuel passageway supplying a small amount of said mixture, of course, whenever the engine runs.

As mentioned, when the manual throttle is opened to accelerate, or when a heavier load is encountered by the engine tending to slow it down, the auxiliary air-fuel passageway is brought into use, by means hereinafter described, to enrich the fuel mixture supplied to the engine. However, as the speed of said engine increases and approaches the speed at which the secondary carbureting chamber is to be brought into use, there is less need for enriching the fuel mixture for accelerating so the auxiliary air-fuel passageway then becomes operative less readily, at certain speeds functioning only when the engine is pulling a heavy load that requires the manually controlled throttle to be open a substantial amount. Then, when the secondary carbureting chamber becomes operative, there is greater need for enriching the fuel mixture for accelerating and the auxiliary air-fuel passageway is, therefore, caused to become operative more readily.

As the speed of the engine is further increased, the natural tendency of the auxiliary air-fuel passageway is to become operative less readily. However, to achieve extremely high engine speeds, it is necessary that the fuel mixture be enriched, compared to the mixture desired at lower speeds, and therefore special means are provided for making the auxiliary air-fuel passageway readily operative at extremely high speeds when the manual throttle is open.

A further object of my invention is to provide a carburetor that will, first, thoroughly atomize the liquid fuel supplied to an internal combustion engine and mix the same uniformly with the air supply, and, second, assure vaporization of said atomized liquid fuel. I achieve said object, in one respect, by providing a uniformly high air velocity through the Venturi tubes of my invention at all operating speeds and loads, whereby liquid fuel entering said air stream is effectively broken up. I achieve said result, in another respect, by providing a uniformly high vacuum at said Venturi tubes, thereby facilitating the vaporization of said atomized liquid fuel according to the well known principle whereby a liquid boils at a lower temperature under vacuum.

A further object of my invention is to provide a carburetor that will properly apportion the liquid fuel to the air passing through said carburetor at various rates of flow of said air, that is, at various speeds and loads of the engine. I achieve said object by utilizing, in conjunction with the aforesaid uniform air velocity and vacuum, an air bleed opening thereto. In other words, instead of applying atmospheric pressure to the air bleeds in the conventional way, I apply thereto the air pressure existing in a portion of my carburetor wherein said air pressure varies with different operating conditions of the engine.

A further object of my invention is to provide a secondary carbureting chamber having an auxiliary throttle valve that will automatically be opened when the capacity of the associated primary carbureting chamber is exceeded at high engine speeds under load. I achieve said object by providing actuating means for said auxiliary throttle valve operative from the vacuum at the primary carbureting chamber venturi. When said vacuum exceeds a predetermined value, corresponding to a certain air velocity through said venturi, said primary carbureting chamber becomes inadequate to supply said engine with a proper air-fuel mixture. I, therefore, cause said auxiliary throttle to be opened progressively when said vacuum increases above said predetermined value.

A further object of my invention is to provide a Venturi choke adapted to be operated synchronously with the auxiliary throttle valve, thereby tending to maintain a constant air velocity through said venturi. Without said choke, when the auxiliary throttle valve is slightly opened, the air velocity through the venturi will be low, whereas I prefer to have a reasonably high velocity therethrough at all times. I, therefore, provide

a choke to restrict the area of said venturi. After said throttle has been opened slightly, thereby increasing said air velocity, I cause said choke to be lifted mechanically as said throttle is further opened, thus maintaining a uniform air velocity.

A further object of my invention is to provide a carburetor having an auxiliary air-fuel passageway whose control valve is controlled by the vacuum existing at various places in said carburetor whereby an enriched fuel mixture will be supplied to an engine when the operating conditions thereof make an enriched mixture desirable.

A further object of my invention is to provide an auxiliary air-fuel passageway whose control valve will open abruptly, when the engine manifold vacuum decreases due either to the slowing down of said engine due to an increased load thereon, or to the opening of the manually operated throttle to accelerate said engine, and close gradually as said vacuum returns to a moderately high value, as it normally will when the load on the engine is reduced allowing it to gain speed, or when the manually operated throttle is partially closed upon the completion of said period of acceleration.

Other objects and advantages of my invention will be described with reference to the accompanying drawings, in which:

Fig. 1 is a plan view of a carburetor embodying my invention, the parts thereof being shown in their usual operating positions, that is with the auxiliary air-fuel passageway closed off from the fuel of the carburetor.

Fig. 2 is a vertical section taken substantially on the line 2—2 in Fig. 1, the upper body section being shown in place in this view, but omitted from the other views for clarity;

Fig. 3 is a foreshortened, large scale view taken substantially on the line 3—3 in Fig. 1, the parts thereof being shown in a position with the auxiliary air-fuel passageway open to the throat to produce an enriched air-fuel mixture.

Fig. 4 is a fragmentary sectional detail view of a portion of the structure illustrated in Fig. 3;

Fig. 5 is a fragmentary horizontal sectional view taken substantially on the line 5—5 in Fig. 6;

Fig. 6 is a fragmentary side view of said carburetor, portions thereof being shown broken away to various depths to disclose the underlying structure;

Fig. 7 is a fragmentary plan view of said carburetor, portions thereof being shown broken away to various depths;

Fig. 8 is a foreshortened vertical section taken along the line 8—8 in Fig. 7, the parts thereof being shown in their usual operating positions, that is, with the auxiliary air-fuel passageway cut off from the throat of the carburetor;

Fig. 9 is a vertical section taken along the line 9—9 in Fig. 5;

Fig. 10 is a large scale vertical section taken on the line 10—10 in Fig. 1, and

Fig. 11, is a more or less diagrammatic illustration of all of the operating parts of the carburetor shown joined together.

Referring first to Figs. 1 and 2, a carburetor embodying my invention comprises a float-valve controlled fuel reservoir 1 having a float 2 and fuel inlet tube 3 adapted to conduct fuel from any suitable supply to said reservoir. Flange 4 at the lower end of said carburetor is adapted to be connected to the intake manifold of an internal combustion engine. The structure thus far described is old in the art.

Fuel from reservoir 1 is supplied to said engine through said conduit by four separate, but not independent, carbureting devices. First, an idling air-fuel passageway is provided for supplying air-fuel mixture at the slow rate necessary for ordinary idling. Said idling air-fuel passageway is, in general, similar to those forming part of carburetors heretofore used. It differs functionally therefrom, however, in one respect in that it is adapted to supply all of the air-fuel mixture required by the engine during idling whereas the manually operated throttle of most carburetors heretofore used has been partially opened during idling. My idling air-fuel passageway differs functionally from those heretofore known in another and more important respect in that it is automatically supplemented by a richer air-fuel mixture from an auxiliary air-fuel passageway hereinafter described in case said engine slows down approaching its stopping point. It follows that said idling air-fuel passageway may be adjusted to supply a rather lean mixture suitable for idling with a warm engine, said mixture being automatically enriched if said engine tends to stop while cold.

Said idling air-fuel passageway comprises a conduit 5, shown more clearly in Fig. 3, leading from chamber 6 which is connected to the intake manifold of an engine by holes 7. Said conduit leads to the atmosphere at its upper end 8, but the flow of air thereinto is restricted by the constriction 9. Constricted air passageways of this kind will be called "air bleeds" herein for convenience. Said air bleeds do not require an extremely small hole in order to restrict sufficiently the flow of air therethrough because of their substantial length. They are ordinarily removable in order that they may be replaced by others having a different bore thereby to adjust the flow of air therethrough. Due to the aforesaid restriction of the flow of air, a substantial vacuum will exist immediately below air bleed 9, and said vacuum is utilized to draw fuel from reservoir 1 through conduit 10. The constricted portion 11 of said conduit controls the flow of fuel therethrough, constrictions of this type being called "fuel metering orifices" herein, in the sense that they restrict the flow of fuel therethru. They may be removable for being replaced with others having different bores, when adjustment is required of the flow of fuel.

Passageways 75 connect said fuel metering orifices to reservoir 1. Interposed in conduit 5 is a manually adjustable valve 12 adapted to control the flow of air-fuel mixture to the engine thereby to control the idling speed of the latter. Said valve functions in the ordinary way as a flow control valve, but it is intended to be more or less permanently set. It will be apparent that a mixture of air from end 8 of conduit 5 and gasoline through fuel metering orifice 11 from reservoir 1 will thus be supplied to said engine, and that the flow of said mixture may readily be adjusted to secure a desirable idling speed of said engine.

Referring to Fig. 8, I will now describe another of the carbureting devices forming part of my invention, namely, the primary carbureting chamber. Barrel 13 leads directly to the intake manifold of the engine at its lower end, and to the atmosphere at its upper end either through draft tube 14 or through the annular opening 15 therearound. Said annular opening is adapted to be partly or wholly closed by member 16 under conditions hereinafter described. The

outer boundary of opening 15 is formed by venturi 17, in which are a series of holes 18 leading to annular chamber 19. Said holes 18 and chamber 19 are used for control purposes hereinafter described, so that, although small quantities of air may flow therethrough under certain conditions, ordinarily no air will flow therethrough and all of the air for said primary carbureting chamber may be deemed to flow through either draft tube 14 or annular opening 15.

Referring now to Fig. 2, fuel for said carburetor is drawn by the vacuum formed in bevelled end 19*a* of tube 20 by the passage of air through draft tube 14. Said vacuum draws said fuel through fuel metering orifice 21 at a rate determined by the bore of said fuel metering orifice and by the bore of air bleed 22. Said air bleed and said fuel metering orifice function like those hereinbefore described differing therefrom in size, of course. The flow of air-fuel mixture through barrel 13 may be manually controlled by throttle valve 23 in the ordinary way. I prefer to make barrel 13 and venturi 17 therein somewhat smaller than usual in order that air shall flow therethrough at a high velocity even at moderate engine speeds.

Principally for supplying an enriched air-fuel mixture for accelerating the engine, I provide an auxiliary air-fuel passageway adapted to draw fuel from reservoir 1 through fuel metering orifice 24 and air through air bleed 25 when vacuum exists in tube 26, auxiliary air being supplied through holes 27, if desired. The resultant mixture is drawn into the engine by way of chamber 6 and holes 7.

The manner in which I control the application of vacuum to tube 26 under various conditions of motor speed and load forms an important part of my invention.

Vacuum from the intake manifold of the engine is applied through holes 7 to chamber 6 at all times while said engine is operating, said vacuum varying, however, under various operating conditions. Whatever vacuum exists in chamber 6 will be applied to tube 26 whenever valve 28 is wide open. However, if valve 28 is partially closed, the vacuum applied to tube 26 will be reduced from that existing in chamber 6 and the rich air-fuel mixture thereby drawn through said tube will be leaned by the admission of air through ports 29. Ports 29 are arranged in spiral pattern extending through the walls of cylinder 30*a* as is shown in Fig. 4. Thus, said ports are consecutively uncovered by piston 30 which is joined to valve 28 by rod 33 and moves with valve 28. Thus, when valve 28 is wide open, as it is shown in Fig. 3, the full manifold vacuum will be applied to tube 26 to draw a rich air-fuel mixture therethrough. When valve 28 is gradually closed, said mixture coming through tube 26 will be progressively leaned by air admitted through ports 29 as they are uncovered, and then shut off by the closing of said valve 28.

Under most operating conditions valve 28 will be closed. However, when the manifold pressure is increased the increased force against piston 31 moves it to the left (Fig. 3) and opens valve 28. This increased manifold pressure, or decreased manifold vacuum, will occur under various operating conditions, all of which require the richness of the air-fuel mixture to be quickly increased, and that is the result achieved by the opening of valve 28. For example, if the engine load is suddenly increased, slowing it down, the manifold vacuum will decrease and the increased force on piston 31 will move it to the left, opening valve 28. A similar result would ensue if the throttle were opened suddenly. But once valve 28 opens even slightly, the manifold vacuum is further reduced due to the admission of air thru ports 29, the force tending to move piston 31 to the left increases and valve 28 opens abruptly.

Motive power is supplied to valve 28 by the difference in air pressure on opposite sides of three pistons, 30, 31 and 32. In addition to valve 28, two of said pistons, namely, 30 and 31, are rigidly connected to valve stem 33, moving therewith at all times. On the other hand, piston 32, slidably mounted in guide member 32*a*, merely abuts against piston 31, and may remain stationary while said valve stem moves. The position of piston 32 may be adjusted by means of screw 32*b*. The aforesaid motive power for actuating valve 28 is derived from the force of atmospheric air on one side of said pistons, the opposite side thereof being subjected to vacuum from the intake manifold of the engine. Piston 31 is always subject to substantially the full vacuum of said manifold, applied through holes 7 and chamber 6. Full atmospheric air pressure is applied to the opposite side of said piston through aperture 34 at all times. Thus, insofar as piston 31 is concerned, the actuating force for valve 28 is proportional to the manifold vacuum.

However, the pressures on both sides of pistons 30 and 32 are variable by means hereinafter described. The force exerted by pistons 30, 31, and 32 on valve stem 33 is opposed by the compression of spring 35, adjustable by screw 36. I contemplate that, under certain conditions, the force of said pistons will be balanced by that of said spring when the latter has been compressed somewhat, while under other conditions the force of said pistons will predominate to force valve 28 firmly against its seat 37. Of course, when the engine is not rotating, there will be no vacuum in its manifold; hence no force will be exerted by said pistons, and spring 35 will move valve 28 to its fully-opened position, screw 46 acting as an adjustable stop therefor. Inasmuch as valve stem 33 is hollow and provided with holes 38 leading to chamber 6, substantially full manifold vacuum is always applied to the right-hand face of piston 30, as viewed in Fig. 3. However, when valve 28 is wide open, said vacuum on the right-hand face of piston 30 is ineffective because a similar vacuum is then applied to its left-hand face. When valve 28 first begins to open, ports 29 are all open and the inrush of air therethrough suddenly reduces the vacuum in chamber 6 and the force on piston 31. Spring 35 then moves stem 33 to the left (Fig. 3) quickly, and I deem this quick movement of stem 33 an important feature of my invention.

Whenever the engine is running and developing a substantial vacuum in its manifold, stem 33 will be moved to the right (Fig. 3), seating valve 28 and raising choke rod 49 (hereinafter described). However, when said manifold vacuum is decreased due to the slowing down of the motor under load or because of a too-lean fuel mixture if it is idling or due to the opening of the manual throttle valve, the force exerted by spring 35 will be greater than that exerted on stem 33 by the pistons carried thereby and said spring will gradually open valve 28. When valve 28 opens slightly, the vacuum in chamber 6 decreases and therewith the force exerted by piston 31 decreases. The result is that the gradual

movement with which valve 28 starts to open is changed to an abrupt movement that carries stem 33 a substantial distance.

Vacuum may be applied to the right-hand end of piston 32, as viewed in Fig. 3, from either of two sources. First, it may be applied through tube 39 from chamber 40. Second, it may be supplied through tube 41 from annular chamber 19, as is shown more clearly in Fig. 2. Said tubes are provided with check valves 42 and 42a to prevent drawing air from one when the other is at higher pressure. That is, if a higher vacuum exists in either tube 39 or tube 41, said vacuum will be effective on piston 32 without interference by the other of said tubes. Said vacuum will be effective against piston 32 because atmospheric air is applied to the left-hand end thereof through orifice 43. However, said atmospheric air pressure is applied somewhat slowly to said left-hand end because of the constriction of said orifice, and vacuum supplied through tube 44 may so reduce the pressure in the left-hand end of cylinder 45 as to retard and delay the action of piston 32. I supply sufficient vacuum through tube 44 to delay the action of piston 32 only at high engine speeds, by means hereinafter described.

The movement of valve stem 33 under the force exerted by pistons 30, 31, and 32 in one direction and the force of spring 35 in the other serves three purposes. First, it opens or closes valve 28. Second, it opens or closes ports 29 in the wall of cylinder 47. Third, cone 48 affixed to valve stem 33 engages rod 49 to raise or lower member 16 by means of yoke 14, spring 50 opposing said raising to cause said member to assume a position determined by the position of said valve stem. I call the mechanism actuated by stem 33 the accelerating valve mechanism.

I will now describe the operation of that portion of my invention thus far described, assuming that high enough engine speeds are not attained to apply sufficient vacuum through tube 44 to impair the operation of piston 32. Before the engine is started, there is no vacuum in the manifold, and spring 35 forces valve stem 33 to the left to the position shown in Fig. 3. This position of said valve stem may be regulated by screw 46, being determined largely by the position of cone 48 with respect to rod 49, it being desired to have member 16 start to raise slightly after stem 33 starts to move to the right.

Now, when the engine is rotated by some external means, a small amount of a moderately rich air-fuel mixture will be drawn through the idling air-fuel passageway hereinbefore described, said amount being regulable by valve 12. In addition thereto, a richer air-fuel mixture will be drawn through the auxiliary air-fuel passageway hereinbefore described. I do not contemplate any other air or fuel being supplied to said engine for starting, although throttle 23 may be opened to draw an air-fuel mixture through the primary carbureting chamber if desired. Supposing throttle 23 to be closed, when the engine starts and attains a slow speed well below normal idling speed, the vacuum applied to pistons 30, 31, and 32 moves said pistons to the right, as viewed in Fig. 3. I prefer to make piston 32 large in diameter in order that said movement may start at very low engine speeds, when the manifold vacuum is rather low.

The first result of said movement is to start to raise member 16, but this is of no importance since throttle 23 is closed. At the same time, piston 30 uncovers one of ports 29, thus achieving two important results. First, it admits air to dilute the rich starting mixture supplied by the auxiliary air-fuel passageway. Second, it reduces the vacuum in both of chambers 40 and 51, thereby reducing the force tending to move said pistons to the right since piston 32 is larger than piston 30.

However when the speed of the engine increases slightly, as it normally will due to the dilution of the rich starting mixture, thereby increasing the vacuum applied to said pistons, the latter will move further to the right notwithstanding the reduction of the vacuum applied to piston 32 due to the uncovering of more of ports 29. Thus, as the engine speed increases, ports 29 are gradually opened and finally valve 28 is closed, whereupon the engine is supplied with an air-fuel mixture by the idling air-fuel passageway only. If, however, the engine is cold, or for some other reason the fuel mixture supplied by said idling air-fuel passageway is temporarily inadequate to maintain the idling speed of said engine and the latter begins to slow down, the vacuum applied to pistons 30 and 31 to hold valve 28 closed will be reduced until spring 35 will cause valve 28 to open slightly whereupon the previously described quick opening of said valve will take place. Said quick opening is highly desirable, in this case, because an enriched mixture is thereby supplied to the engine in time to prevent stopping thereof, whereas if valve 28 opened too sluggishly, the engine would stop.

It should be understood that I do not contemplate the functioning of the auxiliary air-fuel passageway during idling under ordinary conditions, but I do contemplate its use to automatically enrich the fuel mixture supplied to the engine whenever the latter slows down to the point where there is danger of its stopping. I am thus enabled to adjust the idling air-fuel passageway to supply a rather lean mixture, relying upon the automatic enrichment thereof when necessary to prevent stopping of the engine. This results in a saving of fuel, and it also inhibits the formation of carbon in the engine due to the overrich idling mixture that would otherwise be required to prevent stopping of said engine.

If a load should be applied to the engine while the latter is running at idling speed thereby causing it to slow down, the fuel mixture would be enriched in the way just described. This is a desirable result inasmuch as a richer mixture is required by said engine under load. If throttle 23 be slightly opened with the engine running at idling speed, the manifold vacuum will be thereby suddenly reduced by the admission of air through said throttle, and it is desirable that the fuel mixture for said engine be then quickly enriched in order that it may quickly accelerate. This will be achieved by the opening of valve 28 as described, the reduction of the manifold vacuum having the same effect whether caused by the opening of throttle 23 or by the slowing down of the engine. However, the enrichment of the fuel mixture supplied to the engine with throttle 23 partially opened due to the opening of valve 28 will be inadequate if the auxiliary air-fuel passageway controlled by said valve is properly designed to enrich said mixture at idling speeds. I, therefore, augment said enrichment by causing member 16 to be lowered, as described. With throttle 23 closed, said member is ineffective, but its effect increases as throttle 23 is opened, thereby providing an adequately enriched fuel mixture

for rapid acceleration at all engine speeds. Thus, in addition to the auxiliary air-fuel passageway controlled by valve 28, member 16 is also effective to enrich the fuel mixture during acceleration, whereas said auxiliary air-fuel passageway by itself has an important function during the idling of the engine.

As mentioned, I desire to enrich the fuel mixture supplied to the engine quickly for accelerating the same. However, when said engine is operating at moderately high speeds, I do not wish said fuel mixture to be enriched when throttle 23 is slowly opened; the requirement of an enriched mixture is for rapid acceleration, and it would be wasteful to enrich the mixture unnecessarily for slow acceleration. I, therefore, provide tube 41 to apply the vacuum existing about venturi 17 to piston 32 thereby to prevent opening of valve 28 unless the manifold vacuum is reduced sharply by a sudden opening of throttle 23. A slow opening of said throttle thus results in a slight reduction of the vacuum applied to pistons 30 and 31, but said slight reduction does not permit spring 35 to open valve 28 because of the vacuum applied to piston 32 from venturi 17. Furthermore, if throttle 23 is opened suddenly so that valve 28 is opened by spring 35, member 16 will be thereby lowered thus increasing the vacuum at venturi 17, and this increased vacuum acting on piston 32 quickly moves said piston and valve 28 to the right, whereas otherwise an unduly high engine speed would be required to close said valve 28.

Thus, in the structure thus far described, I provide means for automatically enriching the fuel mixture supplied to an engine at idling speeds by means of an auxiliary air-fuel passageway. Said mixture is further enriched, when the manually controlled throttle is open, by a member actuated by the control mechanism of said auxiliary air-fuel passageway—both enriching means are actuated simultaneously. The aforesaid enriching means are actuated by a spring opposed in part by a piston operated directly by the manifold vacuum, and in part by a larger piston to which vacuum is applied only at moderately high motor speeds or when said enriching means are active. The result is that an enriched mixture is supplied promptly for accelerating, and said enriched mixture is maintained until said acceleration is accomplished whereupon the normal, lean mixture is promptly restored.

The structure hereinbefore described constitutes a satisfactory carbureting device except at high speeds wherein it is defective in two respects. First, its capacity for supplying a sufficient amount of fuel mixture is not great enough; the power developed by an internal combustion engine is reduced by restricting its fuel supply. Second, further means for enriching said fuel mixture at extremely high speeds are required, an enriched mixture being essential in order that the engine may reach the highest speed of which it is capable under load. I am aware that the dimensions of the means heretofore disclosed might be enlarged sufficiently to supply an engine with enough fuel mixture. But such enlargement would result in low velocity of the air at and immediately above venturi 17 at low engine speeds. I desire to maintain a high velocity of said air, so I make the structure thus far described only of sufficient size to supply the engine at moderately low speeds thereby achieving said high air velocity even at low engine speeds. I then provide a secondary carbureting chamber for supplying additional fuel mixture at high engine speeds. Furthermore, I increase the air velocity at the venturis under certain conditions by providing air restricting members therefor.

The aforesaid high air velocity at and above venturi 17 is desired for two reasons. First, it produces a high vacuum at the end 19a of tube 20, which is the point at which the fuel begins its major vaporization. It is well known that liquid fuels vaporize more readily under vacuum; indeed, the slow vaporization of said fuels at low temperatures can be fully compensated by a moderate increase in vacuum. Second, high air velocity tends to break up the fuel mechanically, preliminary to its vaporization, and to thoroughly mix the same with the air. The great value of this function will be apparent when it is considered that the time available for the vaporization of liquid fuel, and its intermixture with air, in a carburetor is extremely brief.

Referring now to Fig. 8: Barrel 52 is similar to barrel 13, and the two join at their lower ends to be coupled to the intake manifold of the engine by flange 4. Venturi 53 at the upper end of barrel 52 is similar to venturi 17. I prefer, however, to make venturi 53 somewhat larger than venturi 17 in order to supply ample fuel mixture to said engine at high speeds. The flow of fuel mixture through barrel 52 is controlled by throttle valve 54 which in turn is controlled by the vacuum existing in chamber 19 surrounding venturi 17, means by which said throttle 54 is so controlled being hereinafter described.

Above venturi 53 is a draft tube 55. Said draft tube is adapted to draw fuel from reservoir 1 through tube 65 (see Fig. 6) and fuel metering orifice 57, a small amount of air being admitted through air bleed 58. The means by which fuel is drawn into draft tube 55 differ in no way from those by which fuel is drawn into draft tube 14 except, of course, that different sizes of air bleeds and fuel metering orifices may be used in each. Said venturi is provided with an air restricting member 59 resembling member 16, but differing therefrom, in the form which I prefer, in that it does not completely close the annular space between the venturi and the draft tube, whereas member 16 does completely close the corresponding space when fully lowered. Air restricting member 59 is adapted to be raised by yoke 60 carried by rod 61 (see Fig. 8) which engages cam 62 affixed to shaft 63 which also carries throttle 54. Thus, when said throttle is opened, member 59 will be raised correspondingly. I prefer to shape said cam so that said throttle will be opened substantially before said choke is raised.

I desire throttle 54 to be gradually opened, and member 59 to be gradually raised, when the speed of the engine increases to the point where the velocity of the air through venturi 17 reaches a predetermined value, said value being that at which the performance of said engine begins to be impaired by an inadequate supply of air-fuel mixture. Since the vacuum in chamber 19 increases with said velocity in venturi 17, I utilize said vacuum to open throttle 54, said velocity in venturi 17 thus indirectly causing said opening.

I apply the aforesaid vacuum in chamber 19 to piston 64 in cylinder 65 by means of tube 41 (see Fig. 2). Said vacuum is also applied by said tube to piston 32 in cylinder 45 for the purpose hereinbefore described. Passageway 66 connects the lower end of tube 41 to cylinder 65 as is shown in Figs. 9, 5, and 6. Piston 64 is mounted on rod 67 which carries pin 68 adapted to engage slot 69 in cam 62 to rotate the latter when said piston

moves. Movement of said piston is restrained by spring 70 whose compression is adjustable by screw 71. Thus, when vacuum is applied to cylinder 65, piston 64 will move to the left, as viewed in Figs. 5 and 6, under atmospheric air pressure applied to said piston through hole 72. As said piston moves to the left, pin 68 will cause cam 62 to rotate thus opening throttle 54 and lifting choke 59.

I deem it important that screw 71 be so adjusted that spring 70 has a certain basic compression when no vacuum exists in cylinder 65, that is, I prefer said spring to press piston 64 against the right-hand end of cylinder 65 as is shown in Fig. 5. Then, when vacuum is applied to cylinder 65, piston 64 will not immediately begin to move; it will remain stationary until the force due to said vacuum exceeds said basic compression whereupon a further increase of force due to said vacuum will produce movement of said piston. Thus, throttle 54 will be opened when a predetermined air velocity in venturi 17 is reached, and said predetermined force may be regulated by means of screw 71. By way of example, it may be found that the primary carbureting chamber hereinbefore described becomes inadequate to supply its engine with air-fuel mixture at automobile speeds above 35 miles per hour. Screw 71 may then be adjusted so that throttle 54 will begin to open at an automobile speed of 30 miles per hour, thus bringing into use the secondary carbureting chamber when it is needed. Then, as the speed of said engine is increased further, throttle 54 will be further opened and member 59 further raised until, finally, the full capacity of barrel 52 will be available.

However, the opening of throttle 54 is controlled primarily by the vacuum surrounding venturi 17, which is not necessarily proportional to engine speed. Thus, the engine may operate at high speed with the automobile going downhill without the secondary carbureting chamber being brought into use, because manually operated throttle 23 will then ordinarily be closed, or nearly closed, so that little vacuum will exist above it. I prefer the secondary carbureting chamber to be brought into use only when the engine is operating at high speed and under sufficient load to overtax the primary carbureting chamber, and the means herein described will achieve said result. The vacuum at 17 is an accurate indicator of the need for greater carburetor capacity. It will be understood that the idling air-fuel passageway herein described is also effective at higher speeds, but its capacity is necessarily limited.

I have described means for supplying an engine with the proper quantity of fuel mixture at low speeds and also at high speeds, but at extremely high speeds it is desirable to enrich the fuel mixture so supplied. To achieve this result, I cause the auxiliary air-fuel passageway hereinbefore described to be brought into use at said extremely high speeds. This requires that valve stem 33, and parts assembled thereon, move to the left from the position in which it is shown in Fig. 2.

As mentioned, at low engine speeds, any considerable opening of throttle 23 will cause said valve stem to move to the left. However, at moderately high engine speeds, a substantial vacuum from venturi 17 is applied to piston 32 through tube 41 thereby opposing said movement of stem 33, permitting it to move only when throttle 23 is suddenly opened. At extremely high speeds, the device as described thus far would permit stem 33 to move to the left only upon a very sudden opening of throttle 23; with the normal wide open position of said throttle 23 and of throttle 54 at extremely high speeds, the auxiliary air-fuel passageway would not be brought into use, whereas it is desired that it function at top engine speeds with the throttles open. As mentioned, the reason for this difference is the application of vacuum to piston 32 through tube 41. Therefore, to permit said auxiliary air-fuel passageway to be brought into use readily at high engine speeds with throttles 23 and 54 open, I compensate for the aforesaid application of vacuum to piston 32 through tube 41 by applying vacuum also to the other side of said piston through tube 44 (see Fig. 6).

The vacuum applied to piston 32 through tube 44 is produced by the flow of air-fuel mixture through venturi 53, holes 73 connecting said tube to said venturi. Since said venturi is rendered operative by the opening of throttle 54 only at high speeds, its vacuum can be applied to piston 32 only at said high speeds. However, I do not wish said vacuum to become effective against piston 32 to enrich the fuel mixture supplied to the engine except at extremely high speeds; I do not wish it to become effective at the moderately low speed at which throttle 54 starts to open. This result is achieved through aperture 43 having a bore sufficiently large to permit atmospheric air to be effective against said piston until a rather high vacuum is produced by venturi 53, that is, until extremely high engine speeds are reached. It will be apparent that the speed at which an effective vacuum is applied to the left-hand end of piston 32 may be regulated by varying the bore of aperture 43.

With piston 32 rendered ineffective at extremely high engine speeds, spring 35 will move stem 33 to the left when throttle 23 is opened, the vacuum then effective against pistons 30 and 31 being sufficient to oppose said spring. This results in an enriched mixture for the engine at extremely high engine speeds only when throttle 23 is open, which is the desired result. Of course, the movement of stem 33 to the left not only opens valve 28 to make the auxiliary air-fuel passageway effective, but it also lowers member 16 thus further enriching said mixture.

Although I have described various pistons and cylinders for utilizing different air pressures to control the automatic features of my invention, it will be understood that said pistons and cylinders might be replaced by any suitable form of diaphragm or bellows adapted to produce a similar result without departing from the principles of said invention.

Although I have described members 16 and 59 as air restricting members, the principal function of these members is to increase the velocity of air in order that it may better serve to break up mechanically and intermix with the gasoline, and to increase the vacuum immediately below draft tubes 14 and 55 thereby assuring complete vaporization of said gasoline.

I claim:

1. In a carburetor, a plurality of carbureting devices discharging into a common outlet, one of said devices constituting a primary device and another constituting a secondary device, a manually operated throttle valve arranged in said primary device, a normally closed auxiliary throttle valve arranged in said secondary chamber, means operatively actuated by pressure fluctuations in said primary carbureting device operatively engaging the throttle valve in said sec-

ondary carbureting device, said primary and secondary carbureting devices each including a Venturi tube, a duct leading from the throat of the Venturi tube in the primary device to said means, a choke ring resiliently seated in the mouth of the Venturi tube in the secondary device to decrease the cross-sectional area of the bore of said Venturi tube, said ring being operatively joined to the throttle valve in said secondary device to be unseated when said auxiliary throttle valve is opened, whereby when the auxiliary throttle valve in the secondary device is initially opened said secondary carbureting device is choked and further opening thereof moves said choke ring progressively out of the thoat of the Venturi tube in said secondary carburetor.

2. In a carburetor, a carbureting chamber having air and fuel passageways discharging into said chamber, an automatically actuated accelerating device having an auxiliary air-fuel passageway adapted to discharge a fuel rich air-fuel intermixture into said chamber, a pressure responsive valve mechanism for restricting flow of both air and fuel from said auxiliary air-fuel passageway, and resilient means tending to hold said valve mechanism closed in the presence of a predetermined air pressure within said chamber and to yield in the presence of a greater air pressure within said chamber to permit the discharge from said auxiliary air-fuel passageway into said carbureting chamber.

3. In a carburetor, a carbureting chamber having air and fuel passageways discharging into said chamber, an automatically actuated accelerating device having an auxiliary air-fuel passageway adapted to discharge a fuel rich air-fuel intermixture into said chamber, a pressure responsive valve mechanism for restricting flow of both air and fuel from said auxiliary air-fuel passageways, and resilient means tending to hold said valve mechanism closed in the presence of a predetermined air pressure within said chamber and to yield in the presence of a greater air pressure within said chamber to permit the discharge from said auxiliary air-fuel passageway into said carbureting chamber, and means for progressively increasing the ratio of fuel to air as said valve mechanism moves from seated position to fully opened position.

4. In a carburetor, a carbureting chamber, air and fuel passageways leading to and discharging into said chamber, an automatically actuated accelerating device having an accelerating valve mechanism, an auxiliary air-fuel passageway discharging into said chamber, said accelerating valve mechanism controlling the flow through said auxiliary air-fuel passageway, said accelerating valve mechanism comprising a reciprocally mounted valve stem extending transversely of said chamber, a cylinder opening to said chamber, a piston element operatively mounted in said cylinder, said piston element carried by one end of said valve stem, a plunger carried by the other end of said stem, a plunger cylinder, said plunger operatively mounted therein, a valve carried by said stem, a valve seat lying transversely of said auxiliary air-fuel passageway, said valve in one position being adapted to engage said seat, said valve seat lying intermediate said chamber and said plunger cylinder and elastic means engaging said plunger and being formed and arranged to tend to space said valve from said seat.

5. In a carburetor, a carbureting chamber, air and fuel passageways leading to and discharging into said chamber, an automatically actuated accelerating device having an accelerating valve mechanism, an auxiliary air-fuel passageway discharging into said chamber, said accelerating valve mechanism controlling the flow through said auxiliary air-fuel passageway, said accelerating valve mechanism comprising a reciprocally mounted valve stem extending transversely of said chamber, a cylinder opening to said chamber, a piston element operatively mounted in said cylinder, said piston element carried by one end of said valve stem, a plunger carried by the other end of said stem, a plunger cylinder, said plunger being operatively mounted therein, a valve carried by said stem, a valve seat lying transversely of said auxiliary air-fuel passageway, said valve in one position adapted to engage said seat, said valve seat lying intermediate said chamber and said plunger cylinder, and a series of ports extending from the bore of said plunger cylinder to atmosphere, said ports being spaced longitudinally of that portion of said plunger cylinder traversed by said plunger thereby to be covered and uncovered by said plunger as it moves back and forth in said cylinder.

6. In a carburetor, a carbureting chamber, air and fuel passageways leading to and discharging into said chamber, an automatically actuated accelerating device having an accelerating valve mechanism, an auxiliary air-fuel passageway discharging into said chamber, said accelerating valve mechanism controlling the flow through said auxiliary air-fuel passageway, said accelerating valve mechanism comprising a reciprocally mounted valve stem extending transversely of said chamber, a cylinder opening to said chamber, a piston element operatively mounted in said cylinder, said piston element carried by one end of said valve stem, a plunger carried by the other end of said stem, a plunger cylinder, said plunger being operatively mounted therein, a valve carried by said stem, a valve seat lying transversely of said auxiliary air-fuel passageway, said valve in one position adapted to engage said seat, said valve seat lying intermediate said chamber and said plunger cylinder, an adjustable choke ring in said chamber, a tapered cam on said stem, and a follower operatively engaging said choke ring and said cam, whereby said choke ring is actuated by the reciprocal movement of said stem.

7. In a carburetor, a carbureting chamber, air and fuel passageways leading to and discharging into said chamber, an automatically actuated accelerating device having an accelerating valve mechanism, an auxiliary air-fuel passageway discharging into said chamber, said accelerating valve mechanism controlling the flow through said auxiliary air-fuel passageway, said accelerating valve mechanism comprising a reciprocally mounted hollow bored valve stem extending transversely of said chamber, a cylinder opening to said chamber, a piston element operatively mounted in said cylinder, said piston element carried by one end of said valve stem, said stem being ported to the bore thereof, said ported portion opening to said chamber, a plunger carried by the other end of said stem, a plunger cylinder, said plunger operatively mounted therein, the bore in said stem opening through the plunger and into the plunger cylinder, a valve carried by said stem, a valve seat lying transversely of said auxiliary air-fuel pas-

sageway, said valve in one position adapted to engage said seat, said valve seat lying intermediate said chamber and said plunger cylinder, and elastic means engaging said plunger and being formed and arranged to tend to space said valve from said seat.

3. In a carburetor, a carbureting chamber, air and fuel passageways leading to and discharging into said chamber, an automatically actuated accelerating device having an accelerating valve mechanism, an auxiliary air-fuel passageway discharging into said chamber, said accelerating valve mechanism controlling the flow through said auxiliary air-fuel passageway, said accelerating valve mechanism comprising a reciprocally mounted hollow bored valve stem extending transversely of said chamber, a cylinder opening to said chamber, a piston element operatively mounted in said cylinder, said piston element carried by one end of said valve stem, said stem being ported to the bore thereof, said ported portion opening to said chamber, a plunger carried by the other end of said stem, a plunger cylinder, said plunger being operatively mounted therein, the bore in said stem opening through the plunger and into the plunger cylinder, a valve carried by said stem, a valve seat lying transversely of said auxiliary air-fuel passageway, said valve in one position adapted to engage said seat, said valve seat lying intermediate said chamber and said plunger cylinder, elastic means engaging said plunger and being formed and arranged to tend to space said valve from said seat, a series of ports extending from the bore of said plunger cylinder to atmosphere, said ports being spaced longitudinally of that portion of said plunger cylinder traversed by said plunger thereby to be covered and uncovered by said plunger as it moves back and forth in said cylinder, an adjustable choke ring in said chamber, a tapered cam on said stem, and a follower operatively engaging said choke ring and said cam, whereby said choke ring is actuated by the reciprocal movement of said stem.

9. In a carburetor, a throat having a discharge outlet leading therefrom, an air inlet, a draft tube extending longitudinally of the latter, a fuel conduit discharging into said draft tube intermediate its ends a Venturi tube leading from said draft tube but spaced laterally therefrom, a movable annular choke ring slidably mounted upon said draft tube adapted in one position to seat in said Venturi tube and close the space between the latter and the draft tube, and in another position to be spaced substantially from said Venturi tube to uncover said space, and means actuated by the variance of the pressure of air in said throat for moving said choke from one position to another.

ALLEN E. CHISHOLM.