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April 15, 1941. W. G. McCAIN 2,238,333

CARBURETOR

Filed March 25, 1940

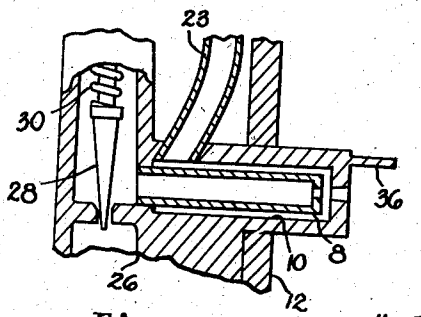


Fig. 3.

Fig. 1.

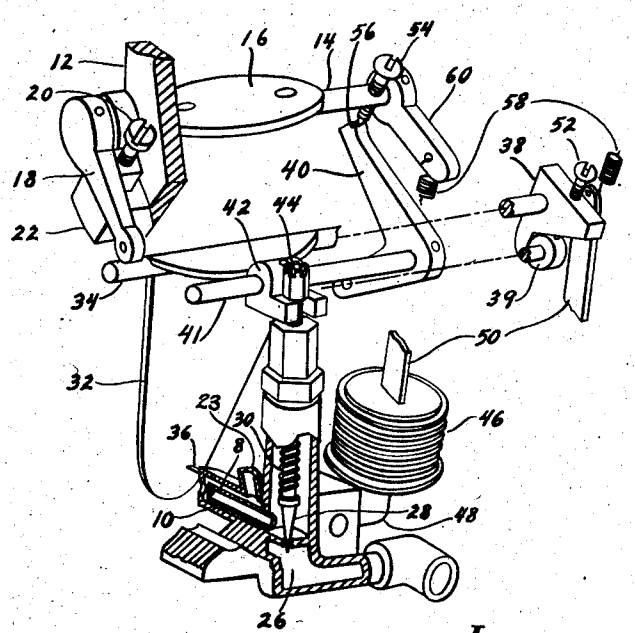


Fig. 2.

Inventor
William G. McCain
by Edward W. Fearing
his atty.

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CARBURETOR

William G. McCain, Medford, Mass.

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11 Claims. (Cl. 261—48)

The present invention relates to improvements in carburetors for internal combustion engines and is hereinafter described as embodied in a carburetor of the floatless or pressure atomizing type in which the flow of fuel from a source of supply under pressure is controlled by an automatically actuated control valve.

It is well known that modern high speed high compression internal combustion engines perform better with a relatively high degree of intake suction. With carburetors of the usual construction there is a period immediately after the throttle valve is opened when the intensity of suction may drop substantially. It is not built up again until greater air flow caused by increased engine speed occurs. Not only does the period of low suction affect the performance of the engine adversely but loss of suction prevents proper vaporization of liquid fuel when vaporization is induced by engine suction only. To overcome this difficulty and to provide proper vaporization under all conditions, it is the practice, particularly with high speed high compression type engines, to employ a number of jets, at least one of which is active during normal running and one during low speed idling conditions in the engine. More often than not a third throttle controlled jet in a single carburetor is provided for increasing the ratio of the fuel in the mixture fed to the engine during periods of engine acceleration. The use of a number of jets in this way renders the construction and adjustment of the carburetor expensive and difficult.

To avoid the use of a number of jets in a carburetor attempts have been made to employ a positive pressure in the fuel supply line behind a single atomizing jet thus making the jet effective over a wider range of engine suction intensities. Such attempts have heretofore failed because improper fuel control, corresponding with all operating conditions in an internal combustion engine such as used in automotive work, has not been provided. Unless special provision is made for controlling fuel flow with a pressure supply to the jet, the ratio of fuel to air delivered to an engine when running slowly with no load will be the same as when running at high speeds with no load and insufficient fuel will be supplied to the engine when under heavy load conditions. As a result, there is loss in efficiency or difficulty in obtaining a prompt response in the engine after opening the throttle. Prior carburetors have been so designed that a compromise between two ratios suited for these conditions of operation is made. The adjustment of the fuel-air mixture therefore is not exactly suited, for either high speed efficiency or quick acceleration of the engine under load conditions. This defect has been present heretofore both in a carburetor having fuel fed from a float level chamber as well as one in which the fuel is fed to the jet under pressure.

One object of the present invention is to provide an internal combustion engine carburetor designed more particularly for automotive work in which a more nearly correct fuel-air mixture ratio together with a higher intake suction than heretofore will automatically be maintained at all engine speeds or load conditions, regardless of increase in throttle openings, whether the fuel fluid is fed to an atomizing jet at atmospheric pressure from a float level chamber disposed adjacent the jet or whether fed under a positive pressure. Another object of the invention is to provide means for building up automatically and independently of throttle opening the intensity of vacuum created in an internal combustion engine before the speed of the engine increases substantially during periods of acceleration, thus rendering it easier to maintain the correct ratio of fuel in the mixture at all times without the use of several jets, and obviating the necessity of making a compromise adjustment for different operating conditions or the possibility of impeding the response of the engine to sudden throttle opening. Other objects are to so control the flow of fuel to an internal combustion engine that effective proportioning of the fuel to air is maintained when the fuel is fed directly to an atomizing jet under pressure throughout the full range of engine operating conditions, including stopping and starting, provision also being made to prevent loss of fuel in stopping and immediate delivery of fuel in proper proportion to prevent loading or choking the engine even when highly heated in starting. Still further objects of the invention are to provide an efficient carburetor of simple and easily manufactured construction and by the use of which more nearly accurate control than heretofore of fuel-air ratio in the mixture in accordance with the demands of the engine under all operating conditions may be obtained.

With these and other objects in view, the present invention relates to the provision in a carburetor for an internal combustion engine having an air conduit, a throttle valve in the conduit and a fuel delivering jet entering the conduit, of

an air actuated means for maintaining and building up the suction in the conduit around the jet more rapidly than caused by increase in air flow from increase in engine speed after opening the throttle valve. The suction being built up more rapidly with this arrangement, causes a more thorough atomization of the fuel from the jet at a time when a large proportion of fuel is being used. This feature of the invention also includes the use of a suction controlling vane disposed close to the jet and directly connected to a static air pressure responsive device in order that an increase of engine suction will reduce the flow of air and will in turn increase the suction and turbulence in the carburetor conduit still further and more rapidly than caused by flow of air from increase in engine speed alone. In connection with this feature the ratio of fuel in the mixture after throttle opening is reduced automatically for efficient continuous low power operating results.

These and other features of the invention will be apparent to those skilled in the art from the following detailed specification and claims and by reference to the accompanying drawing, in which:

Figure 1 is a view in front elevation of a carburetor embodying the features of the present invention together with a power driven fuel pump shown in section as ordinarily employed with an internal combustion engine;

Figure 2 is a perspective view on a slightly enlarged scale illustrating the controlling connections of the carburetor of Fig. 1, parts being broken away, shown in section and in separated relation; and

Fig. 3 is a sectional detail view on an enlarged scale illustrating the construction of the fuel jet and valve of the carburetor.

The carburetor illustrated in the drawing is constructed without a float chamber, liquid fuel being supplied by an engine driven pump, indicated at 2, through a pulsation absorbing air compression chamber 4. The pump 2 is of a well known type, the pumping force of which is effected through a coil spring 6, to give a substantially continuous pressure of approximately three pounds per square inch. From the compression chamber the fuel passes directly to a vaporizing jet 8 arranged within an air induction tube 10 disposed at right angles to the length of a tubular flanged conduit 12 fitted to be clamped against the inlet opening of an internal combustion engine intake manifold (not shown). The conduit 12 has a throttle shaft 14 disposed crosswise in bearings at the upper end of the conduit and a valve plate 16 is secured to the shaft to open or close the entrance to the conduit. To connect the throttle shaft to the accelerator pedal of an automobile the shaft 14 has an actuating arm 18 secured at one end provided with a stop screw 20 bearing against a lug 22 formed on the side of the conduit 12 when the throttle is in closed position. A continuous supply of air is insured in the induction tube 10 by connecting it to the lower end of a bleeder tube 23, the upper end of which is connected with the inside of the conduit above the throttle valve plate 16.

For supplying fuel to the vaporizing jet 8 in the correct proportion to the air passing through the conduit with different throttle openings, the fuel passes from the compression chamber 4 through a tube 24 into valve 26 having a metering pin 28 arranged to be forced by a spring 30 towards the seat of the valve and the valve is arranged to be adjusted automatically to give the correct ratio of fuel to air for all operating conditions in the engine. To increase the supply of fuel with an increase in flow of air past the throttle valve, there is mounted below the throttle shaft 14 an air actuated vane 32 secured to a vane shaft 34 pivotally supported in the walls of the conduit 12 in parallel relation to the throttle shaft 14. At one side of the shaft 34 the vane 32 extends nearly crosswise of the conduit and at the other side of the shaft 34 the air flow retarding portion of the vane extends at an angle downwardly along the length of the conduit. The downwardly extending portion of the vane 32 is so arranged that it will be actuated away from the side of the conduit 12 towards the end of the induction tube into parallel relation to the conduit by an increased flow of air past the throttle and by the metering spring 30 towards the side of the conduit into crosswise relation thereto when the flow of air is reduced. The location of the vane in overhanging relation close to the jet and induction tube causes a relatively high degree of turbulence around the jet to improve the homogeneity of the mixture produced. To prevent the vane from actually blocking the jet, a nib 36 projects from the end of the induction tube where it will be engaged by the vane. When the vane moves towards the jet the fuel valve 26 is opened to allow more fuel to flow into the jet and become atomized.

To open the fuel valve 26 when the vane is moved towards the jet, the vane shaft 34 has secured at one end a cam 38. Cooperating with the cam is a roll 39 rotatable on one arm of a two armed lever 40 secured on a fuel control shaft 41 mounted in bearing lugs extending from the conduit at either side of a forked block 42 secured to the shaft 41. The forked sides of the block embrace the metering pin 28 between the stuffing box for the metering pin and an adjustable nut 44 at the upper end of the metering pin. The arrangement is such that when the flow of air swings the vane towards the jet, the metering pin is raised from its seat. When the flow of air is reduced the vane swings back from the force of spring 30. The cam 38 is cut with the right shape to increase the ratio of fuel to air with increase in amounts of air flowing past the vane 32. With this arrangement a rough approximation is reached for providing a combustible mixture for uniform running conditions in an internal combustion engine. If the nut 44 is adjusted to provide an economical mixture with a low percentage of fuel—for instance, in the ratio of 15 parts of air to 1 of fuel—very poor performance by way of quick engine acceleration after opening the throttle may result. If a richer mixture is used, in the ratio of 12 parts of air to 1 of fuel, better performance occurs in the engine when opening the throttle. The best performance is had when a mixture having a ratio of only 10 parts of air to 1 of fuel is used. With such a rich mixture heavy carbon deposits are formed and general ineconomy results under light load conditions.

According to the principal feature of the present invention a mixture rich in fuel is automatically provided when the throttle is opened for rapid acceleration purposes and as soon as the engine begins to respond to the new conditions imposed by wider throttle opening and greater load, the ratio of fuel is immediately reduced. This result is obtained by automatically causing the engine suction to be built up after

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a sudden throttle opening more rapidly than it would be built up only by increased flow of air into the engine due to increased engine speed. The increased suction is built up by employing a static pressure or suction responsive device in the form of a collapsible metal bellows **46** to cause the vane **32** to cut off the flow of air in part as the engine begins to respond to throttle opening. By so doing the flow of air past the vane increases in speed so that no appreciable reduction in quantity occurs while, due to the changed position of the vane shaft, a smaller amount of fuel passes through the fuel valve. By the time the engine has readjusted itself to the new conditions imposed by opening the throttle a relatively lean mixture is being provided. Also because the suction is built up more rapidly than is possible by increased engine speed alone, where the carburetor is being used with a high speed high compression engine of modern construction, the engine itself operates more efficiently and greater turbulence occurs in the air about the jet and in the engine manifold, so that a more nearly uniform mixture of air and fuel takes place.

The bellows **46** is connected to the inside of the carburetor conduit **12** by an elbow **48** in order to be responsive to changes in static air suction and pressure inside and outside the conduit respectively. The upper closed end of the bellows is connected by a link **50** to an arm of the cam **38** in such relation that increases in suction inside the conduit cause the vane to close off the conduit.

To provide the correct ratio of fuel in the mixture the cam **38** is so shaped that when the engine to which the carburetor is connected is run idly under no load at various speeds, the supply of fuel will be maintained at as small a proportion as possible for all throttle openings throughout the range from closed to fully open position and the connection between the cam and the bellows is arranged to give a stronger effect on the vane shaft as a result of air flow than due to normal suction values; that is, the vane can never be actuated to shut off air flow due to suction effects on the bellows. Thus, the bellows modifies the movements of the vane by shifting it to one side or the other of a position determined by air flow. Under these conditions the degree of vacuum produced by the engine will be a maximum when running idly. If now a heavy load is applied to the engine the suction will drop slightly and the bellows will expand correspondingly, permitting the vane to open the fuel valve accordingly. The result of opening the fuel valve is to give a greater ratio of fuel in the mixture since the flow of air is almost entirely controlled by the throttle valve when the suction is reduced. The same result is effected by sudden throttle opening, a corresponding adjustment taking place as soon as the engine responds to the thottle with increased revolutions. Since these actions are entirely automatic in nature and not under the control of the throttle, correct mixture control is obtainable at all times, causing the highest possible efficiency results throughout the range of throttle openings. Such results are particularly desirable with modern high speed high compression engines having down draft carburetors where any excess of raw unatomized fuel drops directly into the engine to be blown out only partially burned through the exhaust.

It is well known that when an engine is running slowly with no load, a mixture richer in fuel than when under full load is required. To provide a rich idling mixture the arm of the cam has threaded into it an adjustable set screw **52** arranged to touch the roll **39** while the bellows **32** is contracted, as shown in Fig. 1, and lift the metering pin from its seat the proper amount, substantially no air flowing past the vane **32** at this time. When pressed against the roll **39**, the screw **52** moves the roll away from the cam and the vane **32** is moved to its extreme crosswise position in the conduit, closing the conduit. Under these conditions the throttle is practically closed and most of the air drawn into the engine comes through the induction tube **23**. When the engine stops by shutting off the ignition or otherwise the bellows **46** expands and the metering pin spring **30** closes the fuel valve completely by the movement of the cam to a position where the roll **39** fits within the recess formed between the cam and the screw **52**, thus preserving a small supply of fuel under compression in the chamber **4** for starting purposes.

When the throttle is moved from idling position to partly opened position with the engine running, the suction may be reduced sufficiently to cause the bellows to expand. In order to prevent closing of the fuel valve in such instance, by movement of the roll **39** into the recess between the cam and the screw **52**, and thereby stalling the engine, an anti-stall screw **54** passing diametrically through the throttle shaft **14** engages a rib **56** on a second arm of the lever **40**, as shown in Fig. 2. As the anti-stall screw presses against the lever **40** due to the rotation of the throttle shaft from engine idling position (Fig. 1) to slightly open position of the throttle (Fig. 2), the fuel valve is opened to furnish a slightly richer mixture than otherwise would be provided and prevents the valve from being closed by decrease in suction and consequent slight expansion of the bellows to a position where the roll **39** fits within the recess of the cam **38**.

To further improve the operating characteristics of the carburetor, particularly with large throttle openings, a spring **58** is connected between an arm **60** on the throttle shaft and the link **50** to which the bellows is connected. This spring is stretched when the throttle is opened suddenly and is allowed to contract when the throttle is closed, causing little or no tension to be exerted. Thus, the spring **58** tends to decrease temporarily the effect of the bellows and produces a richer mixture for quick acceleration. After the accelerating period is over the action of the increased flow of air on the vane **32** more than offsets the action of the bellows and causes the spring **58** to be relaxed.

With the carburetor thus disclosed, the ratio of fuel supplied to the mixture will be increased with loss of suction in the engine with which the carburetor is employed and will be decreased with increase in suction, whether from throttle opening or from increased load on the engine. Also the suction will be maintained at a higher level generally in the engine due to the rapidity with which the suction is built up again after being reduced. Also since all supply of fuel is cut off when the engine is stopped, the effect of vaporizing the available fuel in the carburetor, particularly in hot weather, is prevented. Consequently a suitable supply is always ready for starting purposes and no trouble from choking the engine in starting occurs.

The nature and scope of the invention having

been indicated and a specific embodiment having been described, what is claimed is:

1. In a carburetor, a mixture conduit, a manually controlled throttle valve in said conduit, a fuel nozzle discharging into said conduit posterior to said throttle valve, a source of fuel under pressure including a fuel passage to the nozzle, a fuel regulating needle valve, means resiliently urging the needle valve in a closing direction, a vane pivotally supported in the conduit between the throttle valve and nozzle, pivoted means mounted adjacent said conduit and having an arm operatively connected to the needle valve and including a lever, a cam operatively connected to said vane and engaging said lever whereby flow of air against said vane tends to swing the same in one direction and to open said needle valve to allow flow of fuel in accordance with air flow in the conduit, and means connected to said vane and responsive to reduction in static pressure in the conduit posterior to the throttle valve whereby decrease in pressure tends to swing the vane in the opposite direction to reduce the needle valve opening.

2. In a carburetor, a mixture conduit, a manually controlled throttle valve in said conduit, a fuel nozzle discharging into said conduit posterior to said throttle valve, a source of fuel under pressure including a fuel passage to the nozzle, a fuel regulating needle valve, means urging the needle valve in a closing direction, a vane pivotally supported in the conduit between the throttle valve and nozzle, pivoted means mounted adjacent said conduit and having an arm operatively connected to the needle valve and including a lever, a cam operatively connected to said vane and engaging said lever whereby flow of air against said vane tends to swing the same in one direction and to open said needle valve and allow flow of fuel in accordance with air flow in the conduit, means responsive to reduction in static pressure in the conduit posterior to the throttle valve, said means being connected to said vane whereby fall in static pressure in the conduit tends to swing the vane in the opposite direction to reduce needle valve opening, and a resilient link between the throttle and vane arranged upon opening the throttle to swing the vane in the first direction to thereby increase the needle valve opening and enrich the fuel mixture.

3. In a carburetor, a mixture conduit, a manually controlled throttle valve in said conduit, a fuel nozzle discharging into said conduit posterior to said throttle valve, a source of fuel under pressure including a fuel passage to the nozzle, a fuel regulating needle valve, means urging the needle valve in a closing direction, a vane pivotally supported in the conduit between the throttle valve and nozzle, pivoted means mounted adjacent said conduit and having an arm operatively connected to the needle valve and including a lever, a cam operatively connected to said vane and engaging said lever whereby flow of air against said vane tends to swing the same in one direction and to open said needle valve to allow flow of fuel in accordance with air flow in the conduit, means responsive to reduction in static pressure in the conduit posterior to the throttle valve, said means being connected to said vane whereby fall in static pressure tends to swing the vane in the opposite direction to reduce needle valve opening, and means comprising a second lever on said pivoted means and means movable with the throttle valve arranged to engage said second lever when the throttle is closed, to open said fuel valve to provide idling fuel.

4. In a carburetor, a mixture conduit, a manually controlled throttle valve in said conduit, a fuel nozzle discharging through an air chamber into said conduit posterior to said throttle valve, a source of fuel under pressure including a fuel passage to the nozzle, a fuel regulating needle valve, means resiliently urging the needle valve in a closing direction, a vane pivotally supported in the conduit between the throttle valve and nozzle, pivoted means mounted adjacent said conduit and having an arm operatively connected to the needle valve and including a lever, a cam operatively connected to said vane and engaging said lever whereby flow of air against said vane tends to swing the same in one direction and to open said needle valve to allow flow of fuel in accordance with air flow in the conduit, means connected to said vane and responsive to reduction in static pressure in the conduit posterior to the throttle valve whereby decrease in pressure tends to swing the vane in the opposite direction to reduce the needle valve opening, and a by-pass conduit extending from the mixture conduit anterior to the throttle to said air chamber for supplying air at substantially atmospheric pressure to said air chamber, whereby the discharge from said nozzle is substantially unaffected by the fall in static pressure produced in the mixture conduit.

5. In a carburetor, in combination, a mixture conduit, a manually controlled throttle valve in said conduit, a fuel nozzle connected to said conduit posterior to said throttle, a source of fuel including a fuel passage to said nozzle, a valve for controlling the flow of fuel through said nozzle, means for urging said valve in one direction, vane means responsive to air flow in the conduit between the throttle valve and nozzle, an operative connection between said vane and said fuel valve to actuate said fuel valve in an opening direction when the vane swings in response to air flow in the conduit, and means connected to said vane means and responsive to reduction in static pressure in said conduit posterior to said throttle valve to actuate said fuel valve in a closing direction upon fall in static pressure in the conduit.

6. A carburetor, a mixture conduit, a manually controlled throttle valve in said conduit, a fuel nozzle discharging into said conduit posterior to said throttle valve, a source of fuel including a fuel passage to the nozzle, a fuel regulating needle valve for controlling fuel flow from said nozzle, spring means for urging said needle valve in one direction, movable vane means in said conduit posterior to said throttle valve and connected to said needle valve to move said needle valve in an opening direction in accordance with air flow in the conduit, and means including a bellows responsive to reduction in static pressure in said conduit posterior to said throttle valve and operatively connected to said needle valve to move the same in a closing direction upon fall in static pressure in the conduit.

7. In a carburetor, a mixture conduit, a manually controlled throttle valve in said conduit, a fuel nozzle discharging into said conduit posterior to said throttle valve, a source of fuel including a fuel passage to said nozzle, a fuel regulating valve having means for urging it in one direction, a movable vane in said conduit pos-

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terior to said throttle valve and movable in one direction by air flow in said conduit, an operative connection between said vane and said fuel valve to cause said valve to be opened in accordance with changes in the air flow, a static air pressure responsive device communicating with said conduit between said throttle valve and said nozzle, and having an operative connection to said vane and tending to move the vane in the opposite direction, and a spring connected between said throttle valve and said vane to provide movement of the fuel valve before the static pressure device operates.

8. In a carburetor, a mixture conduit, a manually controlled throttle valve in said conduit, a fuel nozzle discharging into said conduit posterior to said throttle valve, a source of fuel including a fuel passage to the nozzle, a fuel regulating needle valve having means for resiliently urging it in a closing direction, a shaft disposed in said conduit, a vane on said shaft and responsive to changes in air flow through said conduit, a cam connected to the vane shaft and having a recess, a cam follower connected to the fuel valve and arranged to enter the recess in the cam to permit movement of the fuel valve in a closing direction when the vane moves toward a crosswise position in the conduit, and means operatively connected to the throttle valve for opening the fuel valve and holding the follower away from the recess in the cam during a predetermined initial opening movement of the throttle valve.

9. A carburetor, a mixture conduit, a manually controlled throttle valve in said conduit, a fuel nozzle discharging into said conduit posterior to said throttle valve, a source of fuel including a fuel passage to the nozzle, a fuel regulating needle valve for controlling fuel flow from said nozzle, means for urging said needle valve in one direction, movable vane means in said conduit posterior to said throttle valve and connected to said needle valve and tending to open said needle valve in accordance with air flow in the conduit, said vane means comprising a portion extending generally transverse to the axis of said conduit and an elongated portion extending longitudinally of the conduit and having an area substantially in excess of that of the transverse portion, said two portions forming a continuous surface exposed to air flow in the conduit, and means responsive to reduction in static pressure in said conduit posterior to said throttle valve and operatively connected to said needle valve and tending to close the same upon fall in static pressure in the conduit.

10. A carburetor, a mixture conduit, a manually controlled throttle valve in said conduit, a fuel nozzle discharging into said conduit posterior to said throttle valve, a source of fuel including a fuel passage to the nozzle, a fuel regulating needle valve for controlling fuel flow from said nozzle, means for urging said needle valve in one direction, movable vane means in said conduit posterior to said throttle valve and connected to said needle valve and tending to open said needle valve in accordance with air flow in the conduit, said vane means comprising two connected sections of unequal areas disposed in angular relation to each other and pivot means connected to said sections at their point of divergence and serving to position the smaller section generally transverse to the axis of the conduit and the larger section longitudinally of the conduit, and means responsive to reduction in static pressure in said conduit posterior to said throttle valve and operatively connected to said needle valve and tending to close the same upon fall in static pressure in the conduit.

11. In a carburetor, a mixture conduit, a manually controlled throttle valve in said conduit, a fuel nozzle discharging into said conduit posterior to said throttle valve, a source of fuel under pressure including a fuel passage to the nozzle, a fuel regulating needle valve, means resiliently urging the needle valve in a closing direction, a vane pivotally supported in the conduit between the throttle valve and nozzle, said vane having a first portion transverse to the conduit and a larger portion angularly related to the first and disposed longitudinally in the conduit, a shaft for mounting said vane, said shaft carrying a cam, a roller engaging said cam, a shaft for supporting said roller and connected to said needle valve to actuate said valve in response to movement of said vane, a flexible bellows mounted outside of said conduit and having an interior connection to said conduit, and means for connecting said bellows to said cam to exert a secondary control on said cam in accordance with changes in static pressure in said conduit.

WILLIAM G. McCAIN.