May 16, 1961 O. R. CEDARHOLM 2,984,467

COMBINATION INJECTION CARBURETOR AND FUEL CUT-OFF CONTROL

Filed Sept. 2, 1959 2 Sheets-Sheet 1

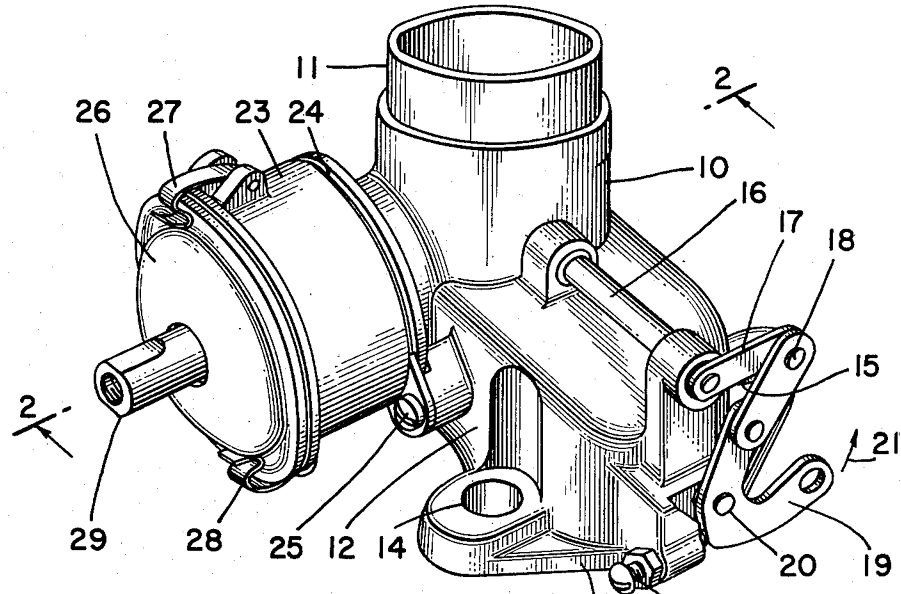

FIG. 1.

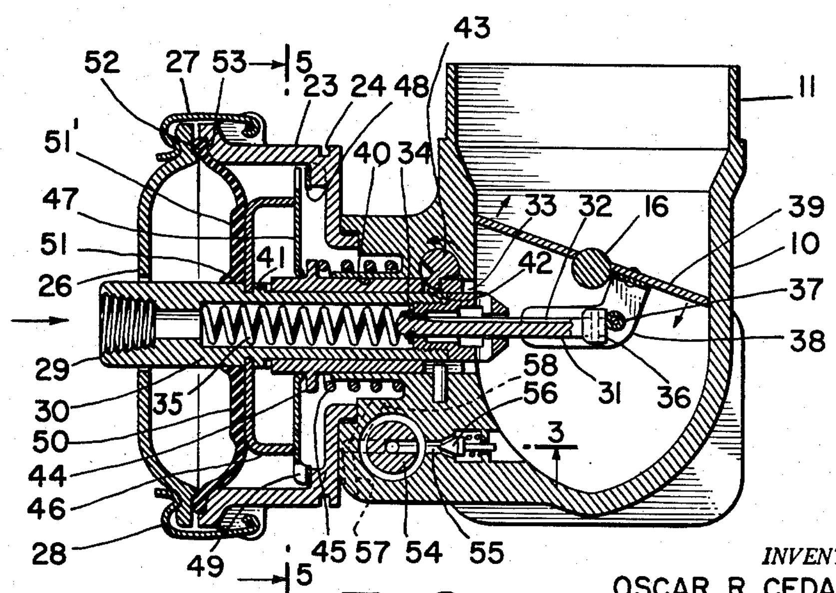

FIG. 2.

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2 Sheets-Sheet 2

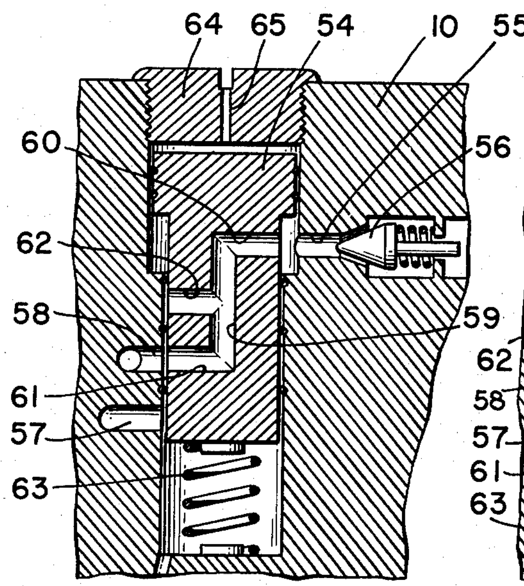

FIG. 3.

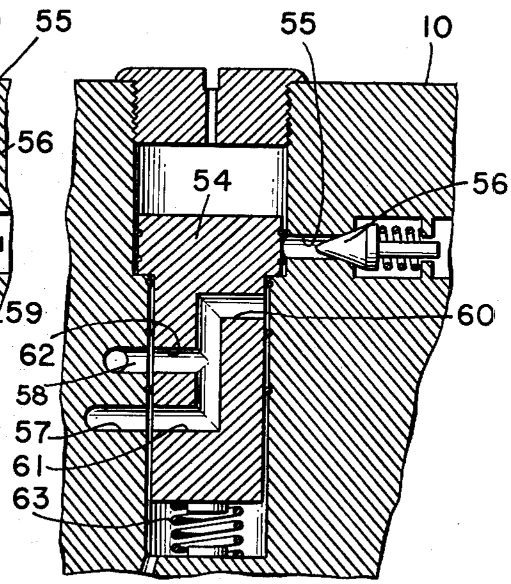

FIG. 4.

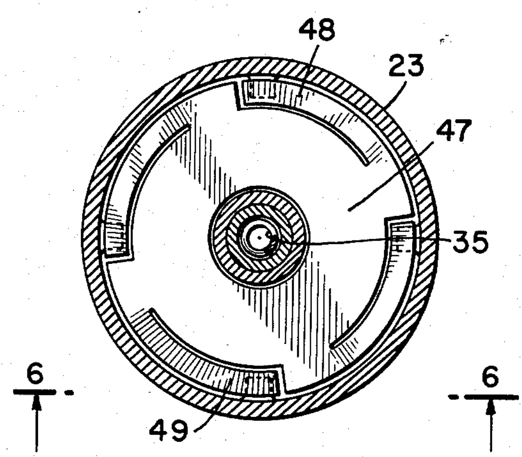

FIG. 5.

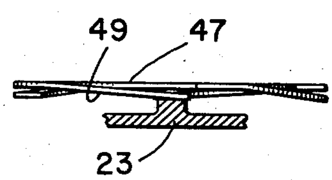

FIG. 6.

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COMBINATION INJECTION CARBURETOR AND FUEL CUT-OFF CONTROL

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7 Claims. (Cl. 261—69)

This invention relates generally to carburetor controlled internal combustion engines and more particularly to an improved combination fuel injection and fuel cut-off control device.

In my prior United States Patent No. 2,762,615 there is disclosed and claimed an improved automatic control in combination with an injection carburetor. Essentially, the device as set forth in said patent insures a proper fuel-to-air ratio throughout the range of operation of a conventional butterfly type throttle valve. This control is achieved by providing an automatic means responsive to varying pressure at the intake manifold working in conjunction with the positioning of the throttle valve to insure a proper amount of fuel injection and avoid the possibility of too rich a fuel mixture in the event of sudden opening of the throttle valve.

It now appears desirable to incorporate means for shutting off the fuel flow completely during deceleration periods to the end that first, fuel is conserved; and second, unburned fuel will not pass out the exhaust and cause air polution. It is believed that such unburned fuel from present day automobiles constitutes one of the primary smog forming ingredients.

With the foregoing in mind, it is a primary object of this invention to provide a combination fuel injection and fuel cut-off control for not only insuring a proper fuel air mixture throughout the operating range of the engine but also providing complete fuel cut-off under decelerating conditions.

Another object of the invention is to provide improved pressure responsive means incorporating a unique type of biasing spring co-operating diaphragm and mounting therefor which enables easy removal and replacement of the diaphragm and facilitates adjustment of the spring force.

Still another important object is to provide a unique throttle linkage connection co-operating with the fuel injection system to enable a finer degree of fuel injection control during initial movements of the throttle towards an open position.

Briefly, these and many other objects and advantages of this invention are attained by providing a control valve responsive to pressure variations at the intake manifold. This control valve co-operates with my improved fuel injection carburetor system in such a manner as to enable complete closing off of the fuel in response to closing of the throttle as occurs during deceleration from a cruise speed. The control valve additionally is designed such as to insure that idling fuel will be present under engine idling conditions. The fuel injection control system itself includes a modified diaphragm and spring biasing system enabling simpler and easier adjustment of the device as well as permitting ready removal and replacement of the diaphragm itself. Finally, there is included an improved linkage system for the throttle which in effect results in relatively slow movement of the throttle upon initial opening thereof, the rate of movement then progressively increasing as the operator depresses the accelerator pedal to a greater degree.

A better understanding of the foregoing as well as further features and advantages of the present invention will be had by referring to a preferred embodiment as illustrated in the accompanying drawings, in which:

Figure 1 is an overall perspective view of my improved carburetor injection and fuel cut-off control system;

Figure 2 is a cross section taken generally in the direction of the arrows 2—2 of Figure 1;

Figure 3 is an enlarged fragmentary cross section partly schematic in form taken in the direction of the arrow 3 of Figure 2, useful in explaining the operation of the fuel cut-off control device;

Figure 4 is a view similar to Figure 3 illustrating a different position of one of the movable components of Figure 3;

Figure 5 is a plan view of the improved biasing member taken generally in the direction of the arrows 5—5 of Figure 2; and

Figure 6 is a fragmentary cross section of the biasing member taken in the direction of the arrows 6—6 of Figure 5.

Referring first to Figure 1, there is shown a carburetor body including a riser **10** terminating in a reduced diameter upper portion **11** for receiving a conventional air filter (not shown). The carburetor body includes an off set portion **12** terminating in a flanged end opening **13** arranged to be secured over the intake manifold of an internal combustion engine as through suitable fastening bolt holes **14** and **15**.

The conventional butterfly type throttle valve within the riser **10** is secured to a control shaft **16** extending laterally from the riser as shown and having its free end secured to a first link **17**. The link **17** in turn is pivotably connected to a second link **18**. The free end of the link **18** connects to one end of an L-shaped actuating lever **19** pivoted at **20** to the off set portion **12**. The free end of the L-shaped lever is adapted for connection to the accelerator pedal. The arrangement is such that movement of the L-shaped lever **20** as in the direction of the arrow **21** upon operation of the accelerator pedal will cause an initial movement of the second link **18** of primarily a rotational nature about its pivot to link **17** so that very little displacement of the first link **17** will occur. However, continued movement of the L-shaped lever **19** will thereafter result in accelerated movement of the first link **17** so that the throttle valve will be actuated slowly at first and then at an increasing rate in response to a uniform movement of the L-shaped lever. This control feature is important in conjunction with applicant's fuel injection system which will subsequently be described with reference to Figure 2.

As shown at the left of the carburetor body in Figure 1, there is provided a housing structure including a laterally extending integral portion of the riser **10**. A portion **23** of this housing structure is provided with an annular groove **24** receiving suitable screw and washer attachments as at **25** to rotatably mount the portion **23** to the extended portion of the riser. This attachment means enables relative rotation of the housing portion **23** with respect to the carburetor body riser portion **10**.

The far end of the housing portion **23** is closed by an end cover **26** held in position by snap fasteners **27** and **28**. An entrance portion of the fuel injection metering valve is shown at **29** for connection to the fuel line supplying fuel to the carburetor body.

Referring now to Figure 2, it will be noted that the entrance **29** extends to the hollow interior of a valve body **30**. The other end of the body **30** includes a valve metering pin **31** longitudinally slidable within the body as shown. The metering pin 31 includes a longitudinal channel 32 terminating at the entrance end of the pin within the end of the valve body 30, in a tapered portion 33. The extreme inner end of the pin includes an annular closure member 34 which will completely close off the end of the hollow portion of the valve body 30 when the metering pin 31 is extended relative to the valve body as far as possible to the right as viewed in Figure 2. A spring 35 normally biases the metering pin in this direction as shown.

The far end of the metering pin terminates in a head structure 36 engaging a cam roller 37 rigidly mounted by means of guide plates 38 to the underside of the butterfly valve 39 secured to the shaft 16 of Figure 1. By this arrangement, clockwise rotation or opening of the throttle valve will cam the metering pin 31 to the left to retract it within the hollow interior of the valve body 30 thereby exposing the longitudinal groove 32 to the interior of the valve body. Fuel will then pass into the carburetor body under the butterfly valve 39. On the other hand, when the throttle valve 39 is completely closed as shown in the drawing, the spring 35 will exert biasing pressure on the pin to urge it to the right to its most extended position which, in the absence of other controls, results in a complete shutting off of the fuel flow through the body 30.

In order to control the proper fuel-air mixture under operating conditions, in addition to the valve structure just described, there is provided an annular stop sleeve member 30 surrounding a reduced diameter portion of the valve body 30. As shown in Figure 2, a small gap 41 exists between the left hand stop end of the sleeve 40 and the beginning of the reduced diameter valve portion. On the other end of the sleeve 40 there is provided an indent 42 receiving a shaped key at the end of a rotatable member 43. Intermediate the ends of the sleeve 40 there is provided an integral outer annular flange 44 co-operating with a spring 45 disposed between the annular flange 44 and integral portion of the riser forming part of the housing. The sleeve 40 is thus biased to the left but is held in a given position by the key portion of the rotatable member 43 within the indent 42.

With the foregoing described structure in mind, it will be evident that by adjusting the rotative position of the member 43, the sleeve 40 can be positioned such as to leave a sufficient gap as at 41 to enable the valve body 30 to slide within the sleeve a short distance to the right. By this arrangement, there is effected relative movement with respect to the valve metering pin 31 so that the action is the same as though the valve metering pin 31 were retracted slightly. Thus, a small flow of fuel can take place along the channel 32 to provide idling fuel for the engine. The member 43 can also be intentionally rotated in the direction of the arrow to slide the sleeve 40 further to the right and thus permit greater sliding movement of the valve body 30 thereby increasing the desired amount of fuel during idling or starting of the engine. The member 43 can thus be employed as a choke.

The valve body 30 itself includes a bell shaped member 46 rigidly connected to the exterior of the body and having an annular open end engaging a disc shaped spring biasing means 47. The disc shaped spring includes peripheral sections bent out of the plane of the disc to provide spring like fingers 48 and 49 engaging a stationary portion of the housing. The disc spring functions to apply a bias against the bell shaped member 46 to the left thus urging the valve body 30 to the left.

Co-operating with the bell shaped member 46 is a flexible diaphragm 50 having an apertured center lined with an annular lip 51 circumferentially engaging in air-tight relationship the exterior of the valve body 30 as shown. The diaphragm itself includes a thickened portion 51' engaging the flat surface of the bell shaped member 46. The outer portions of the diaphragm are relatively thin to provide flexibility. The extreme peripheral edge of the diaphragm terminates in an outer annular lip 52. This outer lip 52 is held within an annular recessed area 53 on the end of the housing, by a correspondingly shaped annular portion on the cover 26. The outer annular lip is thus sealed upon securement of the cover plate. On the other hand, the entire diaphragm may be readily removed by removing the cover plate and simply sliding the diaphragm from the end of the valve body 30. The foregoing design and mounting features thus enable easy replacement of the diaphragm should it become damaged.

The region exterior of the valve body 30 to the right of the diaphragm 50 as viewed in Figure 2 is subject to the intake manifold pressures existing under the butterfly valve 39. The left hand side of the diaphragm, on the other hand, is subject to atmospheric pressure. When the engine is turning over in a normal manner there will be provided a reduced pressure under the diaphragm and the diaphragm will be pulled to the right exerting a pressure against the bell shaped member 46 to in turn urge the entire valve body 30 to the right. In starting the car, the movement of the valve body 30 to the right will take place until the gap 41 is closed and the movement of the valve body 30 is checked by the stop action of the sleeve 40. This movement, as described heretofore, will open up the tapered channel portion of the metering pin 31 sufficiently to enable fuel to pass down the metering pin to the carburetor portion under the butterfly valve 39 and thus permit idling of the engine notwithstanding that the butterfly valve 39 may be substantially closed.

Co-operating with the foregoing structure of Figure 2 is a fuel cut-off control valve including a piston 54 positioned within a chamber recessed from the lower integral extending portion of the riser body 10. This chamber connects to a first passage 55 communicating through a check valve 56 with the carburetor portion beneath the butterfly valve 39. This passage is thus subject to the intake manifold pressure. The chamber also connects to a second passage 57 communicating with the atmosphere, and with a third passage 58 communicating with the under or right hand side of the diaphragm 50.

Referring particularly to the cross sectional views of Figures 3 and 4, it will be noted that the piston 54 is provided with internal passage means 59 extending laterally to the right as at 60 to communicate with the passage 55, and turning to the left at 61 to communicate with the passage 58 when the piston is in the position shown in Figure 3. A third lateral passage 62 communicates with the passage 58 when the piston is in the position shown in Figure 4. A spring 63 is disposed under the lower end of the piston to urge it upwardly as viewed in Figure 3 to one position. A cover cap 64 with vent 65 encloses the upper end of the piston. If a sufficient vacuum is provided in the passage 55, atmospheric pressure through the cover cap 64 by way of vent 65 will move the piston downwardly against the bias of spring 63 to another position as illustrated in Figure 4.

Figure 5 illustrates in greater detail the disc spring 47 described in connection with Figure 2 wherein it will be noted that the spring biasing fingers 48 and 49 constitute circumferential sections cut and bent out of the plane of the disc as described heretofore. Figure 6 illustrates the positioning of these fingers with respect to the stationary housing portion 23 and it will be noted that the extreme ends of the fingers are engaging the housing portion. In this relative rotative position of the disc spring, minimum spring biasing is applied. However, by rotating the entire housing structure upon loosening of the fastening screw 25 of Figure 1, the engaging housing portion on the spring fingers can be moved arcuately away from the ends to engage other portions of the spring fingers further from their free ends thereby increasing the biasing force exerted by the disc spring. This structure thus enables adjustment of the biasing pressure in a simple and direct manner without requiring any disassembly of the housing.

With the foregoing description of the various components making up the invention in mind, the operation of the overall system will now be described. Referring again to Figure 2, the relative positions of the various parts show the closure member 34 of the fuel metering pin 31 completely closing off the tapered channel 33 from communication with the interior of the valve body 30 so that no fuel can pass into the carburetor body. Upon initial turning over of the engine, a reduced pressure will develop under the butterfly valve 39 at the intake manifold which reduced pressure will result in the diaphragm 50 urging the bell shaped member 46 to the right against the bias of the disc spring 47 thereby urging the valve body 30 to the right until it abuts the left hand end of the sleeve 40. The valve metering pin 31 on the other hand is held stationary by the camming roller 37 and therefore cannot move with the valve body 30. The tapered portion of the channel is slightly opened and fuel will therefore pass into the carburetor portion under the butterfly valve 39 thereby starting the engine and maintaining it in an idling condition. As mentioned heretofore, more of this fuel can be injected by resetting the rotative member 43 to enlarge the gap 41 and thus permit further right hand movement of the valve body 30 in response to the reduced pressure.

As the operator depresses the accelerator pedal, the butterfly valve 39 will be initially rotated very slowly to the right through the various linkages described in connection with Figure 1. This motion will cause the valve metering pin 31 to be retracted as a consequence of the engagement of the cam roller 37 with the head 36 of the pin. Retracting movement of the valve metering pin within the valve body 30 will thus open up a greater area of the channel 32 thereby permitting increased fuel to flow into the carburetor body. Further depression of the accelerator pedal to rotate the butterfly valve 39 further in a clockwise direction will cause correspondingly retraction of the fuel metering pin to the left within the valve body 30.

To maintain the desired fuel-air mixture, and prevent the mixture from becoming too rich when the butterfly valve is suddenly opened, the valve body is also caused to execute movements to control the amount of fuel passing through the channel. Thus, as the butterfly valve 39 is suddenly opened up further, the intake manifold pressure beneath this valve increases. As a consequence, there will not be as much pressure exerted on the left side of the diaphragm 50 as before and the disc spring 47 will move the entire valve body 30 to the left. This leftward movement of the valve body 30 tends to decrease the area of the channel 32 exposed to the interior hollow portion of the valve body 30 and thus acts to reduce the fuel flow through the channel. The mixture is thus leaned out by action of the reduced intake manifold pressure. If the butterfly valve 39 is slowly turned in a counterclockwise direction towards a closed position, it will be evident that the spring 35 will hold the head 36 of the fuel metering pin in engagement with the cam roller 37 and thus the pin will move slowly to the right tending to decrease the amount of fuel supplied. On the other hand, the gradual closing of the butterfly valve will also result in establishment of a greater vacuum at the manifold intake which will in turn cause the diaphragm 50 to urge the valve body 30 also to the right and thus tend to decrease the relative differential movements between the valve metering pin 31 and valve body 30. Accordingly by this control, an optium fuel-air mixture can always be maintained. Moreover, this desired ratio is maintained entirely automatically in accordance with variations in the intake manifold pressure.

If the operator of the vehicle should suddenly close the throttle butterfly valve 39 by lifting his foot from the accelerator when the car is moving at cruising speed, the continued momentum and turning over of the engine by motion of the car will create a sudden decrease in pressure under the butterfly valve 39. This sudden decrease in pressure will be sufficient to cause the piston 54 in Figure 3 of the fuel cut-off control valve to move from the position shown in Figure 3 to the position shown in Figure 4. In the position shown in Figure 4, atmospheric pressure will be communicated through the passage 57, internal passages 61 and 62, and out passage 58 to the area to the right of the diaphragm 50. The diaphragm will no longer then exert any force on the valve body 30 with the result that the disc spring 47 will retract the valve body 30 to its extreme leftward position. In this position and with the butterfly valve 39 closed to permit maximum extension of the fuel metering pin 31, the fuel flow will be completely closed off by the closure member 34. With the fuel flow entirely cut off, fuel is conserved during the decelerating period and also unburned fuel is prevented from passing through the engine. As a result, smog forming ingredients in the exhaust are avoided.

As the engine approaches idling condition, the pressure at the intake manifold gradually increases until a value is reached such that the piston spring 63 of Figures 3 and 4 can overcome the atmospheric pressure acting on the top of piston 54, and move it from the position illustrated in Figure 4 back to the position illustrated in Figure 3. In this position, the still reduced intake manifold pressure will be communicated through the passage 55, internal passage 59, to the passage 58 to the right of the diaphragm 50 and thus cause the diaphragm to move the valve body 30 to the right in Figure 2. This action opens the channel in the metering pin 31 a sufficient amount to permit idling fuel to pass to the carburetor portion under the butterfly valve 39. Thus, while the fuel is cut off during deceleration from cruising speed, it is automatically turned on again under idling conditions to prevent the engine from dying.

The check valve 56 prevents any possible back flow which might destroy the normal vacuum maintained under the diaphragm 50.

As mentioned heretofore, the provision of the various throttle linkages 17, 18 and 19 described in connection with Figure 1 insure that initial opening movements of the butterfly valve 39 will be relatively gradual which is desirable in that such slow movements will be imparted to the fuel metering pin 31 and thus enable a fine degree of initial fuel injection control. By adjusting the bias forces exerted by the disc spring 45 and the piston spring 63, the described actions for optimum operation are assured.

From the foregoing description, it will be evident that the present invention has provided a greatly improved carburetor fuel injection and automatic fuel cut-off system. Not only is the single diaphragm used easily replaceable, but the provision of the novel disc spring structure enables easy adjustment of the spring bias force. This adjustment is such as to insure movement of the valve body 30 to its extreme left position to effect fuel cut off when atmospheric pressure is communicated to the under or right hand side of the diaphragm 50 through the control valve piston 54.

While a specific embodiment of the present invention has been shown and described, minor modifications that clearly fall within the scope and spirit of the invention will occur to those skilled in the art. The combination fuel injection and cut-off control is therefore not to be thought of as limited to the particular structure shown and described merely for illustrative purposes.

What is claimed is:

1. In an internal combustion engine including an intake

manifold and a carburetor having a riser and throttle mounted in said riser, the combination comprising: fuel injecting means responsive to movements of said throttle for providing a metered portion of fuel, said fuel injecting means also including pressure responsive means responsive to pressure variations at said intake manifold to also vary said metered portion of fuel; and a control valve responsive to said pressure variations at said intake manifold for controlling said pressure responsive means in response to closing of said throttle when said engine is turning over at cruising speed to block all fuel from passing through said fuel injecting means.

2. The subject matter of claim 1, in which said control valve controls said pressure responsive means to unblock fuel flow when said engine attains an idling condition.

3. In an internal combustion engine including an intake manifold and a carburetor having a riser and throttle pivoted in said riser, the combination comprising: a housing formed in part by said riser and supporting a fuel metering valve, said valve extending into said riser between said throttle and said intake manifold and subject to pressure variations at said intake manifold, said valve including a valve body movably mounted in said housing and having a hollow interior for passing fuel into said riser; a fuel metering pin slidable in the end of said valve body and biased into said riser to engage a portion of said throttle so that opening movements of said throttle retract said pin within said valve body, said pin including a longitudinal channel tapered at its entrance end within said valve body so that its relative longitudinal position within said body determines the quantity of fuel that can pass into said riser along said groove; a movable stop sleeve surrounding said valve body to limit movements of said valve body within said housing; pressure responsive means within said housing secured to said valve body to slide said valve body within said sleeve in response to pressure variations at said intake manifold thereby varying the relative longitudinal positions of said valve body and fuel metering pin; spring means opposing said pressure responsive means biasing said sleeve towards its furthest retracted position; and a control valve responsive to a decrease in said intake manifold pressure to a given value for removing said intake manifold pressure from said pressure responsive means and subjecting said pressure responsive means to atmospheric pressure, whereby said spring means urges said valve body to its furthest retracted position within said housing so that blocking of fuel flow through said valve body is effected by said fuel metering pin when said throttle is closed.

4. The subject matter of claim 3, in which said housing includes a chamber portion having first, second, and third passages communicating respectively with said intake manifold, atmospheric pressure, and said pressure responsive means in said housing, said control valve including a piston slidable in said chamber and including

internal passage means for connecting said first and third passages when in one position and disconnecting said first and third passages and connecting said second and third passages when in another position; means biasing said piston to said one position, said piston moving from said one to said another position in response to said decrease in intake manifold pressure to said given value.

5. The subject matter of claim 3, in which said pressure responsive means includes a diaphragm having a central opening through which said valve body passes; an inner annular lip portion lining said opening to engage the exterior of said body and form a tight seal therewith; a bell shaped stiffening member secured to said valve body and providing a surface area against which said diaphragm rests said spring means exerting biasing pressure against said bell shaped member, said diaphragm having an outer annular lip, and said housing having an annular recessed area and including a cover plate for holding said outer annular lip within said recessed area when said cover plate is in position whereby said diaphragm is readily replaceable.

6. The subject matter of claim 5, in which said spring means includes a disc shaped member surrounding said valve body and including a plurality of peripheral sections extending given circumferential distances and bent out of the plane of said disc to define spring fingers, said fingers engaging stationary portions of said housing and the other side of said disc engaging said bell shaped member, relative rotation between said stationary portion and said fingers varying their engagement positions and therefore the spring bias force exerted by said disc shaped member, whereby said bias force may be adjusted.

7. The subject matter of claim 3, including a throttle linkage formed of first and second links and an L-shaped actuating lever, said first link being connected at one end to actuate said throttle upon rotation, and said second link being pivotably connected at one end to the other end of said first link and having its other end connected to one end of said L-shaped actuating lever in such a manner that initial movement of said L-shaped actuating lever causes relatively slow movement of said first link through said second link, further movement of said actuating lever increasing the rate of movement of said first link, whereby initial retracting movement of said fuel metering pin by said throttle is effected more slowly when said throttle is initially opened, and at a greater rate of speed upon further opening of said throttle.

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