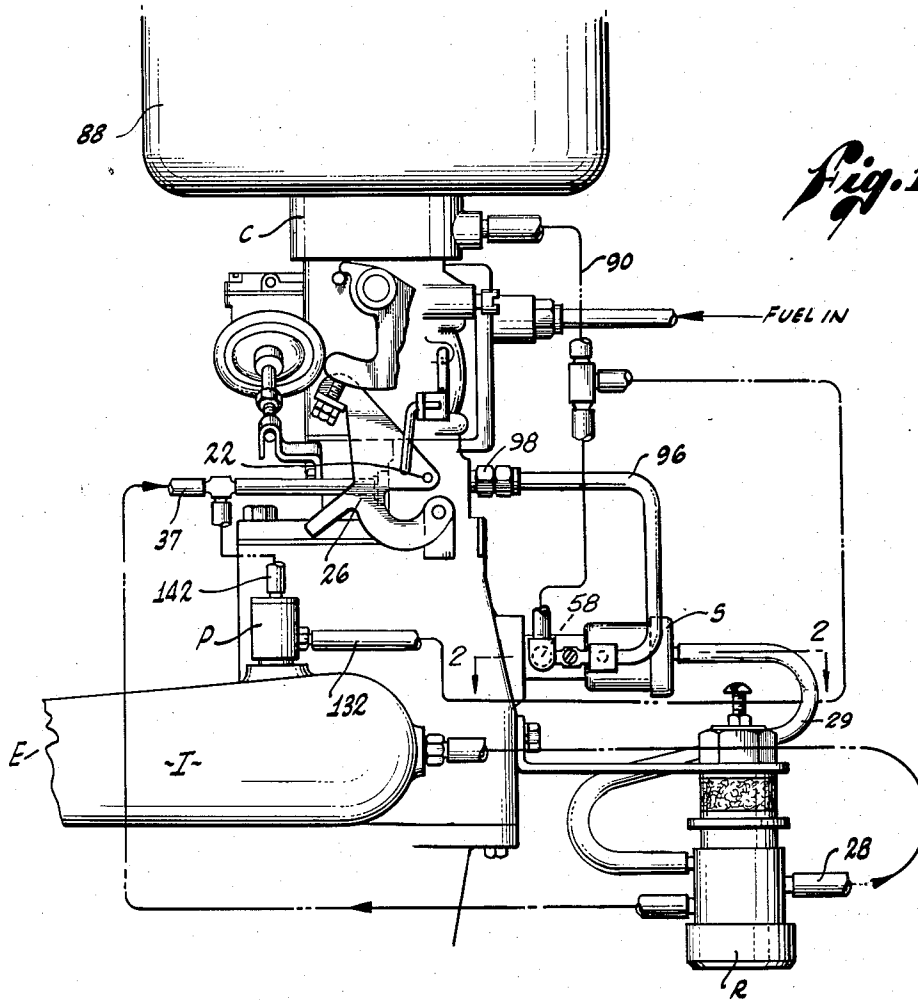


Filed Dec. 2, 1955

FUEL SHUT-OFF APPARATUS

4 Sheets-Sheet 1



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FUEL SHUT-OFF APPARATUS

2,879,756

Filed Dec. 2, 1955

4 Sheets-Sheet 2

Fig. 7

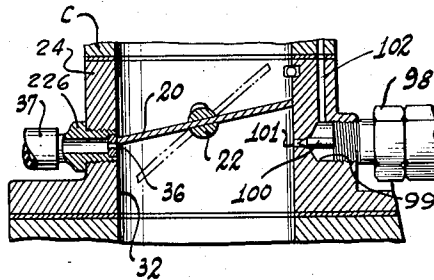


Fig. 2

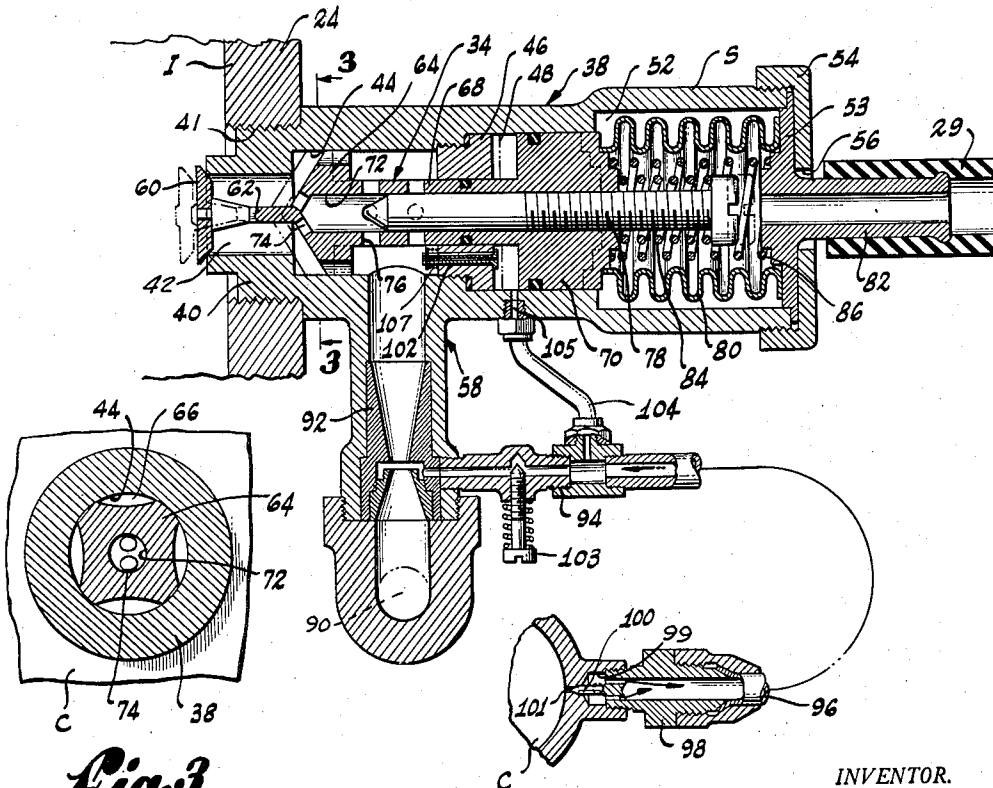


Fig. 3

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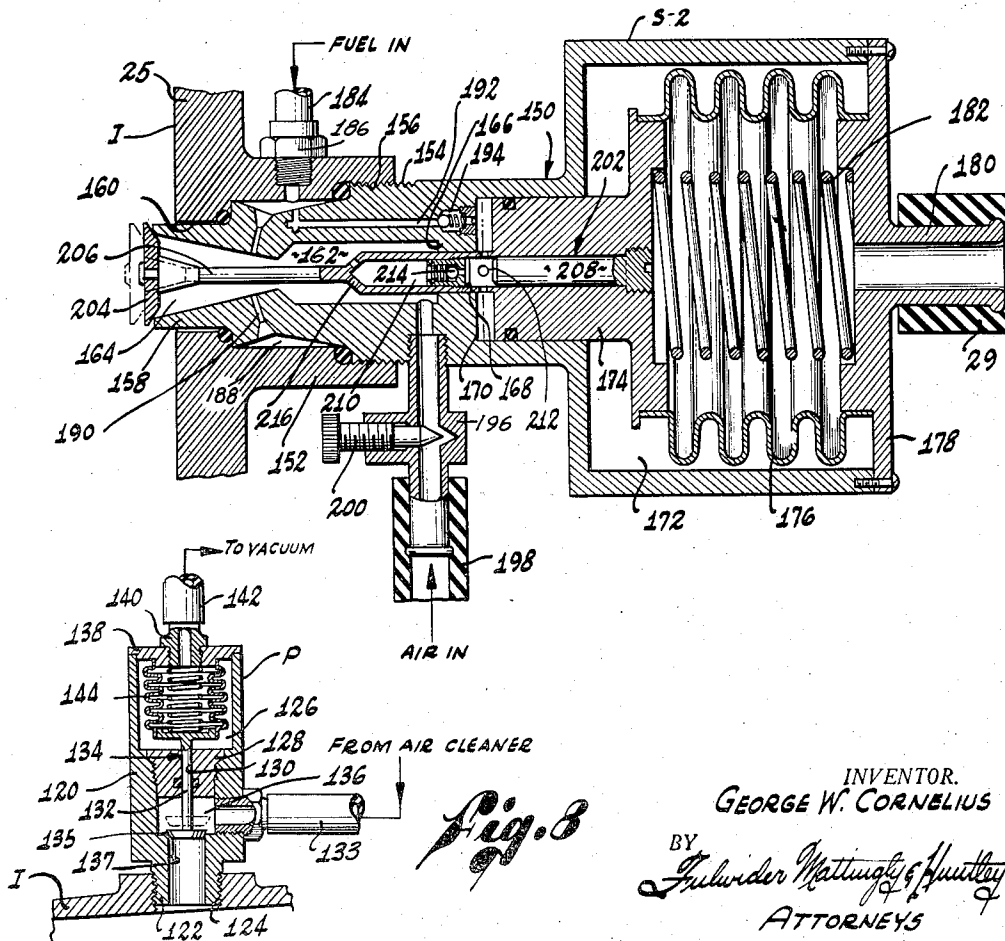
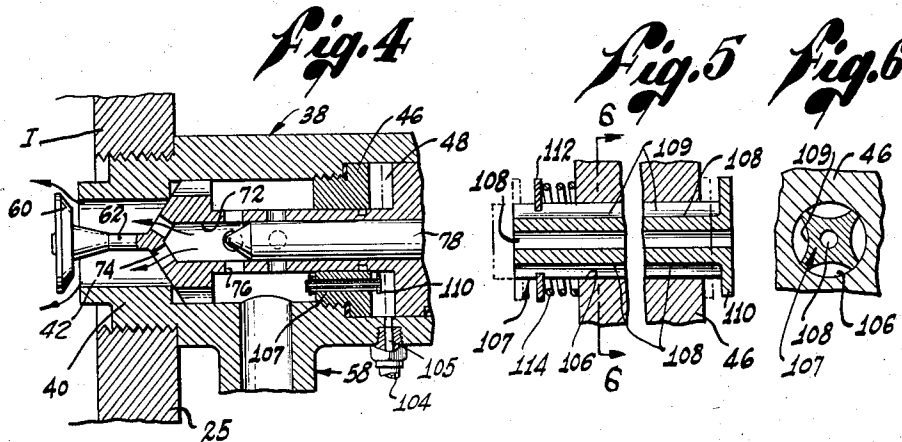
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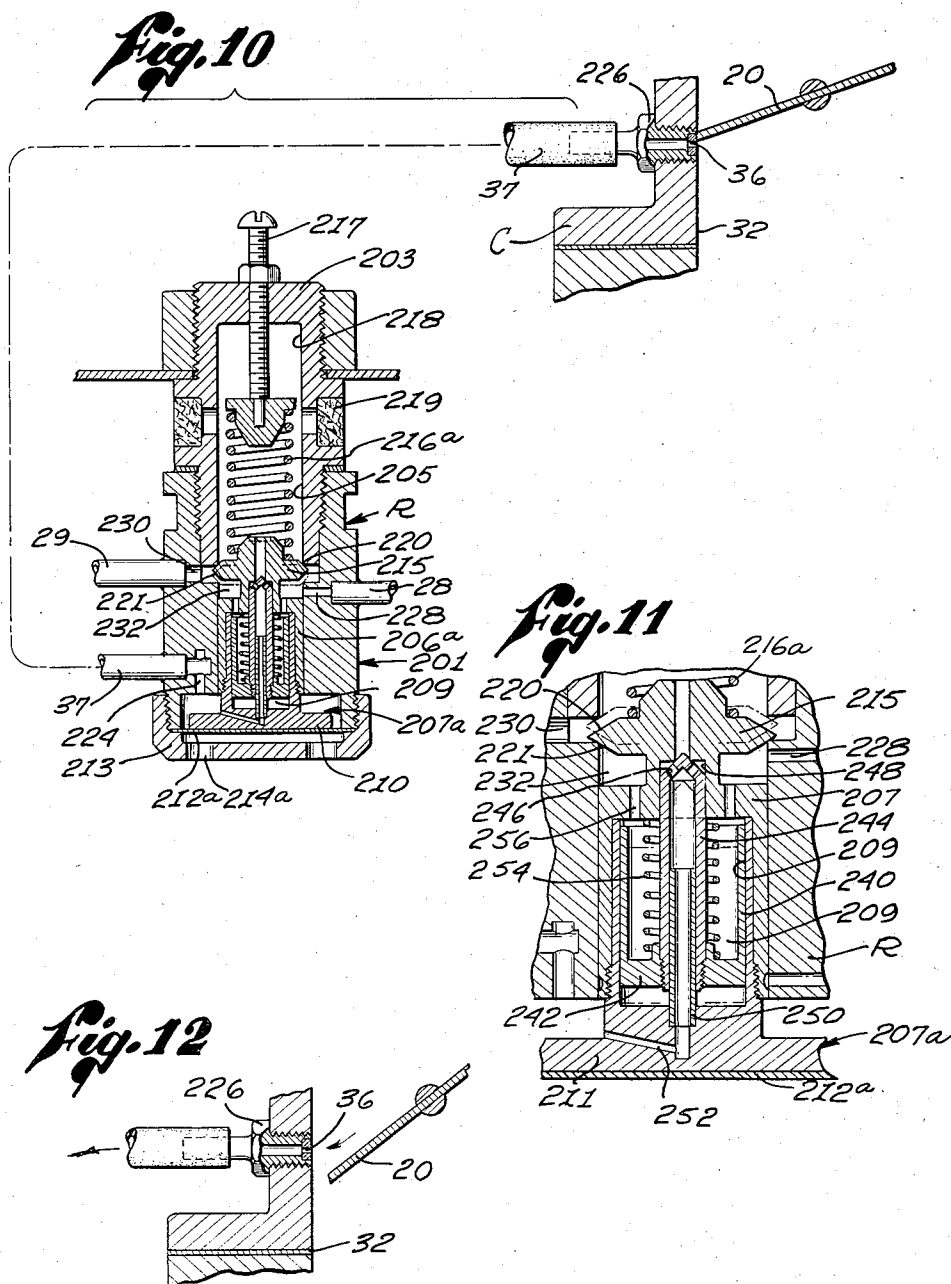
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4 Sheets-Sheet 4



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2,879,756

FUEL SHUT-OFF APPARATUS

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Application December 2, 1955, Serial No. 550,598

23 Claims. (Cl. 123-97)

The present invention relates generally to internal combustion engines and more particularly to an improved fuel shut-off apparatus for use therewith.

It is well known that the unburned products of combustion exhausted from internal combustion engines of automotive vehicles constitute a prime source of the so-called "smog" which exists in and around the principal population centers of the country. The harmful effect of this smog upon animate and inanimate objects are likewise very well known. Since the inception of smog and recognition of its detrimental effect upon health and plant life, extensive research has been carried on to find ways and means of diminishing the internal combustion engine's contribution to smog. Much attention has been given to the deceleration cycle, at which time there is no useful work accomplished through the combustion of fuel and at which time, it has been determined, the largest percentage of unburned products of combustion are exhausted from the engine. These unburned products of combustion result from the fact that during the time the engine is being rotated under the momentum of the vehicle at a speed greater than that obtained by the carburetor throttle setting, an extreme vacuum exists within the engine's cylinders and intake manifold. This high vacuum tends to draw fuel from the carburetor into the combustion chambers of the engine. The existence of this high vacuum does not permit adequate compression within the combustion chambers to take place and accordingly the fuel fails to undergo complete burning. These unburned hydrocarbons are exhausted into the atmosphere where they contribute to the smog content. Additionally, the existence of these unburned hydrocarbon products form carbon deposits within the combustion chambers and the exhaust valve ports and remainder of the exhaust system. These disadvantages are in addition to the reduction in mileage resulting from the loss of fuel from the carburetor during deceleration. The deceleration period is utilized, to a certain extent, for the purpose of slowing down or contributing braking effect to the vehicle. This is particularly true on grades sufficiently steep to effect an overrunning condition where the forward motion of the vehicle is cranking the engine against compression. It has been found that in cases where the fuel is completely shut off from the engine during periods of deceleration, a greater force is required to crank it at overrunning speeds. It therefore follows that with an effective fuel shut-off the braking effect during deceleration is improved.

In an effort to overcome these disadvantages it has been heretofore proposed to provide automatic shut-off devices for positively stopping the flow of fuel through the carburetor during deceleration of the engine. When the throttle valve is reopened, fuel is again permitted to flow into the intake manifold. While certain of these devices have functioned fairly satisfactorily they do not always permit the engine to smoothly commence operation after the deceleration period. Instead, the engine

2

is likely to undergo stumbling and faltering when the throttle valve is first reopened. Such rough operation results from the fact that during a deceleration period the intake manifold will usually have been substantially dried out. Accordingly, when the throttle valve is reopened less fuel enters the intake manifold than is required to support normal idling of the engine. Hence, the engine momentarily undergoes stumbling and faltering.

It is a major object of the present invention to provide a novel and improved fuel shut-off apparatus adapted to stop the flow of fuel to the intake manifold during deceleration.

A more particular object is to provide a fuel shut-off apparatus which momentarily delivers an extra charge to the intake manifold when the throttle valve is reopened after a period of deceleration whereby the engine will operate smoothly and without stumbling or faltering.

Another object is to provide fuel shut-off apparatus of the aforescribed nature which is extremely sensitive in action, is capable of shutting off and turning on the fuel at the proper time and that includes a fuel blocking plug which opens in the same direction as the flow of fuel.

It is yet a further object of the invention to provide a fuel shut-off apparatus of the aforescribed nature which is simple in design and rugged of construction whereby it may afford a long and trouble-free service life.

A further object of the invention is to provide fuel shut-off apparatus of the aforescribed nature that may be readily installed upon the engine of any conventional automotive vehicle without requiring extensive modification thereof.

An important object of the invention is to provide fuel shut-off apparatus of the aforescribed nature which includes means for venting the intake manifold to the atmosphere as the vehicle decelerates to a point just above normal engine idling speed whereby the normal tendency for the engine to stall is eliminated.

Another object is to provide fuel shut-off apparatus of the aforescribed nature which is not affected by fuel-carried foreign matter and which requires a minimum amount of maintenance.

These and other objects and advantages of the present invention will become apparent from the following detailed description when taken in conjunction with the appended drawings, wherein:

Figure 1 is a side elevational view of a first form of shut-off apparatus embodying the present invention mounted upon an internal combustion engine;

Figure 2 is an enlarged horizontal sectional view taken on line 2-2 of Figure 1 and showing a fuel shut-off member forming a part of said apparatus;

Figure 3 is a vertical sectional view taken on line 3-3 of Figure 2;

Figure 4 is a fragmentary view showing the elements of said fuel shut-off member disposed in a different position;

Figure 5 is an enlarged view of a detail shown in Figure 4;

Figure 6 is a vertical sectional view taken on line 6-6 of Figure 5;

Figure 7 is an enlarged fragmentary central vertical sectional view showing the throat of the carburetor of said engine and its relation to said apparatus;

Figure 8 is an enlarged central vertical sectional view of a pressure regulating member forming a part of said apparatus;

Figure 9 is a central horizontal sectional view of a second form of fuel shut-off member which may be utilized in said apparatus; and

3

Figures 10, 11 and 12 show the construction and operation of a regulator valve utilized with said apparatus.

General arrangement

Referring to the drawings and particularly Figures 1 and 7 thereof, a preferred form of fuel shut-off apparatus embodying the present invention is shown mounted upon a conventional internal combustion engine E having an intake manifold I and a conventional carburetor C. The carburetor C includes a butterfly type throttle valve 20 which is keyed to a horizontal shaft 22. This shaft 22 passes through the walls 24 of the carburetor so as to support the throttle valve 20 for pivotal movement relative thereto. One end of the shaft 22 protrudes through the carburetor walls 24 so as to receive the throttle arm 26. The latter is connected to the accelerator pedal of the automobile vehicle wherein the engine E is mounted by suitable linkage means (not shown). With this arrangement, counter-clockwise rotation of the throttle arm 26 will effect movement of the throttle valve 20 from its closed or idling position shown in solid outline in Figure 7 towards its open or dotted outline position shown in this figure. The throttle valve 20 is normally biased towards its closed position by suitable spring means (not shown).

The first form of fuel shut-off apparatus embodying the present invention includes a regulator valve R shown in dotted outline mounted at the lower right hand side of Figure 1, an air-fuel shut-off member S mounted on one side of the intake manifold I and a pressure regulating valve P shown mounted at one side of the intake manifold I. The regulator valve R may be of the type shown and described in my co-pending application Serial No. 540,817 filed October 17, 1955, now Patent No 2,868,182 and entitled Fuel Shut-Off Apparatus. In general, the regulator valve R serves to place the shut-off member S in communication with the interior of the intake manifold I during deceleration of the automotive vehicle by means of conduits 28 and 29 in a manner to be fully described hereinafter.

Referring now to Figures 1 through 7, the first form of air-fuel shut-off member S is adapted to effect a positive stoppage of the idling fuel normally entering the intake manifold I during deceleration of the engine E. To this end, the air-fuel shut-off member S includes a metering pin, generally designated 34, which is disposed in its open or dotted outline position of Figure 4 during operation of the engine other than when the latter is decelerating. During deceleration, this metering pin 34 will be moved to the right to its closed or solid line position of Figures 2 and 7. As indicated hereinabove, preferably the sensing means for effecting operation of the air-fuel shut-off member S will include the regulation valve R. The regulator valve R receives its sensing force from an opening 36 formed in one side of the carburetor wall 24. This opening 36 is connected to the regulator valve by a conduit 37.

Detailed description of the air-fuel shut-off member shown in Figures 2 through 7

With particular reference to Figures 2 through 7, the first form of air-fuel shut-off member S includes a generally cylindrical main body 38 wherein the metering pin 34 is coaxially disposed. The front or left-hand portion of the body 38, relative to Figures 2 and 4, is formed with an externally threaded nipple element 40 which is threadably secured within an internally threaded bore 41 formed in the intake manifold wall 24. The nipple element 40 is coaxially formed with a cylindrical inlet passage 42, the rear of which merges into a cylindrical metering chamber 44. This inlet passage 42 constitutes the idling fuel outlet of the carburetor C. A centrally apertured plug element 46 serves to separate the metering chamber 44 from a coaxial dashpot chamber 48 of slightly larger diameter. The rear of the dashpot cham-

4

ber 48 in turn merges into the front of a diaphragm chamber 52 of still larger diameter. The rear of this diaphragm chamber 52 is closed by means of a plug 53 that is held in place by a cap element 54, the latter being threadably affixed to the right-hand side of the body 38. This cap element 54 is coaxially formed with a bore 56. As indicated in Figure 2, the metering chamber 44 is intersected by an elbow 58 through which fuel may enter the air-fuel shut-off member.

The front end of the metering pin 34 is formed with an annular plug element 60 adapted to seal off the front of the inlet passage 42. This plug element 60 is of frusto-conical profile and tapers radially outwardly and forwardly relative to the inlet passage 42. A coaxial post 62 of smaller diameter than that of the inlet passage 42 integrally connects the plug element 60 with a stopper element 64 adapted to seat against the rear end of the inlet passage 42. This stopper element 64 is disposed at the front end of the stem 68 of the metering pin 34. The radially outer portion of the stopper 64 is formed with flutes 66. The rear end of this stem 68 is integrally connected to a dashpot piston 70. A coaxial bore 72 extends through the dashpot piston 70 and the stem 68. The front end of this bore is in communication with the inlet passage 42 by apertures 74 formed in the stopper element 64. Rearwardly of the stopper element 64, the stem 68 is formed with a plurality of radially extending ports 76. An adjustment bolt 78 having a tapered front end is threadably disposed within the coaxial bore 72. The dashpot piston 70 is slidably disposed within the dashpot chamber 48. A flexible, metallic bellows 80 is rigidly secured to the rear end of the dashpot piston 70. The opposite end of this diaphragm is rigidly affixed to the plug 53. The plug 53 is centrally formed with a rearwardly extending tubular boss 82 which extends through the bore 56 of the cap element 54. The bore 82 is connected to the end of the conduit 29 leading from the regulator valve R. The adjustment bolt 78 is releasably retained in place by means of a helical compression spring 84 interposed between the underside of the head of the bolt and the rear surface of the dashpot piston 70. The dashpot piston 70 and hence the metering pin 34 is constantly biased forwardly towards its open position by means of a second helical compression spring 86 interposed between the rear surface of the dashpot piston and the front surface of the plug 53.

As indicated in Figures 1, 2 and 7 the end of the elbow 58 remote from the main body 38 is connected to the engine's air cleaner 88 by conduit means 90. A venturi 92 is interposed between the conduit means 90 and the outer end of this elbow 58. With this arrangement air entering the elbow passes through the venturi 92 so as to draw liquid fuel through the throat thereof, such liquid fuel entering through a fitting 94. The fitting 94 is attached to a conduit 96, the opposite end of which may be connected to a second fitting 98 that is threaded into the bore 99 of the carburetor C adjacent the throttle valve 20 which normally holds the idling jet (not shown). This fitting 98 includes a plug 100 for closing the idling jet 101 in order that liquid fuel from the idling passage 102 will enter the conduit 96. The amount of fuel passing into the venturi 92 may be controlled by means of an adjustment bolt 103 mounted in the fitting 94. With this arrangement, a mixture of air and liquid fuel will be drawn into the metering chamber 44 during operation of the engine E. It should be noted that a by-pass conduit 104 connects the fitting 94 with a port 105 formed in the body 38 adjacent the rear portion of the storage chamber 48.

Referring particularly to Figures 4, 5 and 6, the plug element 46 is formed with a vent passage 106 which connects the rear portion of the metering chamber 44 with the dashpot chamber 48. An elongated bleeding element 107 is slidably disposed within this vent passage. This bleeding element 107 is centrally formed with a

5

bleed passage 108 as well as with a plurality of longitudinal flutes 109. The rear end of the bleeding element is affixed to a sealing ring 110 that is adapted to cooperate with the rear surface of the plug element 46 to block the flow of fluid through the flutes 109. The front end of the bleeding element 107 is formed with a retainer ring 112. A helical compression spring 114 is interposed between the retainer ring 112 and the front surface of the plug element 46. With this arrangement, the bleeding element 107 is normally biased forwardly to its position of Figures 2 and 4.

With regard to the above-described first form of air-fuel shut-off member S, during operation of the engine E other than deceleration, the metering pin 34 will be disposed in its open position of Figure 4. At this time the tapered front end of the stopper 64 will be seated against the rear periphery of the inlet passage 42. Hence, the only route which the air and fuel mixture may follow into the inlet passage 42 is through the metering chamber 44, the stem ports 76, the front portion of the stem bore 72 and the aperture 74 formed in the stopper 64. When the engine commences a period of deceleration, the regulator valve R will cooperate to connect the interior of the bellows 80 with the high vacuum then existing within the intake manifold I in a manner fully described hereinafter. As a result, the piston 70 and hence the metering pin 34 will be drawn rearwardly, or to the right relative to their positions of Figures 2 and 4, into their solid outline position of Figure 2. In such position, the plug element 60 will effect sealing with regard to the flow of fluid through the inlet passage 42. Additionally, as the piston 70 moves rearwardly it will draw the bleeding element 107 rearwardly so as to move the sealing ring 110 away from the rear surface of the plug element 46. Accordingly, the interior of the dashpot chamber 48 will be filled with fuel by means of the flutes 109, as well as the passage 108. As the piston 70 reaches its rearmost position, the interior of the storage chamber 48 will be connected with the fitting 94 by means of by-pass conduit 104 and port 105. Hence, complete filling of this chamber with liquid fuel will be assured.

It will be apparent that so long as the deceleration period continues, the flow of fuel into the carburetor C will be positively blocked by the plug 60 of the air-fuel shut-off member S. At the conclusion of the deceleration period, the regulator valve R will vent the interior of the bellows 80 to the atmosphere in a manner fully described hereinafter. The spring 86 will then be free to return the dashpot piston 70 and hence the metering pin 34 to their normal position of Figure 4. The speed at which the piston 70 returns to its original position will be controlled by the rate at which the fuel trapped in the dashpot chamber 48 flows through the bleed passage 108 of the bleeding element 107. Until the stopper 64 engages the rear end of the inlet passage 42, fuel entering the metering chamber 44 will be free to flow into the inlet passage through the flutes 66 of the stopper 64 as well as by means of the normal route through the interior of the stem 68 of the metering pin 34. Accordingly, it is possible to force sufficient fuel into the carburetor C to insure its smooth recovery after the deceleration period. It should be particularly noted that as the plug element 60 moves into the confines of the intake manifold I in vertical alignment with the carburetor throat 32 it will tend to draw the fuel trapped behind it into the intake manifold. This assists the prompt and smooth recovery of the engine after a period of deceleration.

The pressure regulating member P

Referring now to Figures 1 and 8, the pressure regulating valve P controls the pressure within the intake manifold I and is adapted to effect smoother recovery of the engine E when the air-fuel shut-off member S

6

is utilized. The pressure regulating valve P includes a generally cylindrical body 120 formed at its lower end with a nipple 122 that is threadedly secured in an opening 124 formed in the intake manifold I. The upper portion of this body 120 is formed with a cylindrical cavity 126, the lower end of which is sealed by a plug 128. The plug 128 is coaxially formed with a bore 130 wherein is slidably disposed the stem 132 of a poppet valve 134 having a head 135. Below the plug 128 is formed another cavity 136, one side of which is in communication with the air chamber 88, and hence the atmosphere, through a conduit 133. The bottom of this lower cavity 130 merges into a bore 137 formed through the nipple 122. The upper end of the upper cavity 126 is closed by a cap 138 wherein is threadably disposed a fitting 140. This fitting 140 is secured to a conduit 142 which is in communication with the conduit 37 which leads to the opening 36 in the carburetor walls 24, as shown in Figure 1. The upper end of the stem 132 is rigidly secured to the lower end of a metallic bellows 144, the latter having its upper end in turn rigidly secured to the underside of the cap 138.

With the aforescribed arrangement, at such time as the throttle valve 20 is in its closed position of Figure 7, the interior of the metallic bellows 144 will be in communication with the vacuum existing below the closed throttle valve. Accordingly, it will draw the stem 132 and hence the poppet valve head 135 upwardly out of its seated position shown in solid outline in Figure 8 to its dotted outline position shown therein. In this manner the interior of the intake manifold I will be vented to the atmosphere and the vacuum existing within the intake manifold will immediately be reduced.

With this arrangement, the air-fuel shut-off member S will move from a closed to an open position during a deceleration period sooner than would be the case if the pressure regulating member P was not utilized. Thus, assuming a situation where an automobile equipped with the aforescribed apparatus is decelerating from 50 to zero miles per hour, and the air-fuel shut-off member is adjusted to open normally when the automobile has reached a speed of 20 miles per hour, if the fuel shut-off apparatus does not include a pressure regulating member P. Next, if, however, the fuel shut-off apparatus does include a pressure regulating member, the latter could be adjusted so as to admit atmosphere to the intake manifold at 25 miles per hour. Thus, the fuel shut-off member would be caused to move from a closed to an open position at 25 miles per hour. If this is the case, it will be apparent that more revolutions of the engine will be available for forcing the fuel admitted to the intake manifold when the air-fuel shut-off member opens into the engine's combustion chambers. Thus, as the automobile comes to a stop its engine will have sufficient fuel to avoid any rough operation. This might not be the case where the fuel shut-off member would not open until the automobile had slowed to 20 miles an hour. It should also be noticed that the use of the pressure regulating member P prevents oil from being scavenged from the sump of the engine E during a deceleration period. This scavenging tendency would be very great where the throttle valve 20 is completely closed during a deceleration period as contemplated by the aforescribed apparatus, especially inasmuch as no fuel will be entering the engine's combustion chambers and hence no burning will be taking place.

Detailed description of the air-fuel shut-off shown in Figure 9

Referring now to Figure 9, there is shown a second form of fuel shut-off member S-2 which may be utilized with the apparatus of the present invention. This air-fuel shut-off member S-2 includes a generally cylindrical main body 150 secured within a tubular boss 152 extending from the intake manifold wall 24. The intermediate

portion of the body 150 is formed with external threads 154 that are engaged with complementary internal threads 156 formed at the outer portion of the boss 152. The front portion of the body 150 includes a nipple 158 which is inserted within a bore 160 formed in the intake manifold wall 25. The body 150 is coaxially formed with an inlet passage 162, the front portion of which defines a venturi 164. The rear end of the inlet passage 162 is defined by a radially inwardly extending partition 166. This partition 166 is coaxially formed with bore 163. Rearwardly of the partition 166 there is defined a cylindrical fuel storage chamber 170. A bellows chamber 172 is formed rearwardly of the storage chamber 170. A piston 174 is slidably disposed within the storage chamber 170. The rear end of this piston is rigidly affixed to the front end of a metallic bellows 176 having its rear end in turn rigidly affixed to a cap 178. The cap 178 forms a closure for the rear end of the bellows chamber 172. The cap 178 is centrally formed with a fitting 180 that receives the conduit 29 leading from the regulator valve R. The piston 174 is constantly biased forwardly by helical compression spring 182 which is interposed between the rear surface of the piston and the front surface of the cap 178.

Fuel enters inlet passage 162 by means of a conduit 184 secured to the carburetor boss 152 by means of a suitable fitting 186. The latter is in communication with an annular space 188 defined between the interior of the boss 152 and a cut-away portion of the body 150. The space 188 is in communication with the venturi 164 by means of a plurality of radially inwardly and forwardly extending metering ports 190. This space 188 is also in communication with the storage chamber 170 by a passage 192 wherein is disposed a rearwardly opening spring-loaded check valve 194. Air enters the inlet passage 162 by means of a suitable fitting 196 threaded into one side of the body 150. This fitting 196 is secured to one end of a conduit 198 having its opposite end connected to the engine's air cleaner 88. An engine idling speed adjustment bolt 200 is preferably disposed in this fitting 196.

A metering pin, generally designated 202, is coaxially disposed within the body 150. This metering pin 202 is formed at its front end with an annular plug element 204 adapted to block the flow of fuel through the front end of the inlet passage 162. A coaxial post 206 of smaller diameter than that of the inlet passage integrally connects the plug element 204 with the stem 208 of the metering pin. The rear portion of this stem 208 is rigidly secured to the piston 174. The stem 208 is formed with a bore 210 which is in communication with the storage chamber 170 by means of a plurality of ports 212. A forwardly-opening check valve 214 is disposed in the stem 208 forwardly of the ports 212. The front end of the stem bore 210 is in communication with the inlet passage 162 by means of apertures 216.

In the operation of the air-fuel shut-off member S-2, during operating conditions of the engine E other than deceleration, the metering pin 202 will be disposed in its open or dotted outline position of Figure 9. At this time, air will enter the inlet passage 162 through the conduit 198 and fitting 196. Liquid fuel meanwhile enters the throat of the venturi 164 by means of the conduit 184, fitting 186, annular space 188 and ports 190. When the engine undergoes deceleration, the interior of the bellows 176 will be placed in communication with the interior of the intake manifold I by means of the conduits 28 and 29 and the regulator valve R. This will serve to draw the piston 174 and hence the metering pin 202 to their solid outline position of Figure 9 at which time the plug element 204 will block the flow of air and fuel into the carburetor C. It should be particularly observed that as the piston 174 moves rearwardly or to the right it will draw liquid fuel through the passage 192 into the storage chamber 170. In this regard, more fuel will enter the annular space 188 than is required by the metering

ports 190, hence sufficient additional fuel will be available for filling the storage chamber 170. When the engine stops decelerating, the regulator valve R will vent the interior of the bellows 176 to the atmosphere. The spring 182 will then return the piston 174 to its open position. As the piston 174 moves to the left, the charge of liquid fuel drawn into the storage chamber 170 will be forced through the stem bore 210 and apertures 216 into the inlet passage 162. This extra charge of fuel will serve to prevent faltering or stumbling of the engine E as it recovers from the deceleration operation.

Referring now to Figures 1, 10, 11 and 12, there are shown the details of construction of the regulator valve R. The regulator valve R includes a body generally designated 201 and a bonnet 203 which is threaded into the upper portion thereof. The body 201 is centrally formed with a vertical bore 205 wherein is slidably mounted the stem 207 of a valve member 207a. The stem 207 is formed with a cylindrical cavity 209 and its lower end is rigidly affixed to the head 211 of the valve member 207a while the underside of this head 211 is secured to a flexible metallic diaphragm 212a. The periphery of the diaphragm 212a is secured to the underside of the body 201 by means of a threaded cap member 213 wherein are formed apertures 214a. The upper end of the valve stem 207 is formed with a piston element 215. The piston element 215 and hence the valve member 207a are constantly biased downwardly by a coil compression spring 216a. The adjustment of this spring 216a may be controlled by an adjustment bolt 217 which is threadably carried by the upper end of the bonnet 203. The spring 216a and the lower portion of the adjustment bolt 217 are disposed within a cylindrical cavity 218 formed in the bonnet 203. This cavity 218 is in communication with the atmosphere through suitable filter material 219. The piston element 215 includes an upwardly-facing sealing surface 220 and a downwardly-facing sealing surface 221. The upper surface of the diaphragm 212a is connected to the conduit 37 by a passage 224 formed in the body 201.

As shown in Figure 10, the opposite end of the conduit 37 is connected to the throat 32 of the carburetor C by means of the opening 36, formed in a fitting 226 to which is attached the conduit 37. As indicated in Figures 7 and 10, when the throttle valve 20 is in a closed position the opening 36 is cut off from communication with the throttle bore 32 above the throttle valve 20. The opening 36 is therefore in communication with the intake manifold pressure existing below the throttle valve 20. As indicated in Figure 12, when the throttle valve 20 is in an open position, however, the edge of the throttle valve proximate the opening 36 moves downwardly away from this opening and the latter is thereby placed in communication with the portion of the carburetor throat 32 above the throttle valve 20. With this arrangement, when the throttle valve 20 is in an open position the diaphragm 212a will be exposed to atmospheric pressure on both its upper and lower surfaces, inasmuch as during the time the opening 36 is uncovered, the upper surface of the diaphragm will be placed in communication with the atmosphere through the conduit 37 and body passage 224. When the throttle valve 20 is disposed in its closed position of Figure 10, however, the opening 36 will be blocked from communication with the atmosphere and accordingly the upper surface of the diaphragm 212a will be exposed to the intake manifold vacuum existing below the throttle valve.

The spring 216a should be so adjusted that it will exert sufficient downward force against the piston element 215 that the diaphragm 212a cannot flex upwardly under the influence of the vacuum existing underneath the throttle valve 20 during idling. The diaphragm 212a should be capable of upward flexure, however, under the influence of the higher vacuum which results during deceleration conditions. Upward movement of the piston element

215 from its solid outline position of Figure 11 to its dotted outline position therein serves to place a passage 228 formed in the right-hand side of the body 201 with a second passage 230 formed in the left-hand side of this body by means of an annular space 232 between the upper and lower sealing surfaces 220, 221, respectively, of the piston element 215. As shown in Figure 1, the first passage 228 is in communication with the intake manifold 1 by means of the conduit 23. It should be noted that the intake manifold pressure is constantly balanced with regard to its effect upon the vertical movement of the piston element 215 inasmuch as the first passage 228 empties into the annular space 232. The second passage 230 is connected to the boss 82 of the air fuel shut-off member S of Figure 2 by means of the conduit 29. The second passage 230 is likewise connected to the boss 180 of the air fuel shut-off member S2 of Figure 9 by means of the conduit 29.

Referring particularly to Figure 11, in order to obtain a quicker action of the regulator valve R an open-topped cup 240 is slidably disposed within the cylindrical cavity 209 of the stem 207. The bottom wall 242 of this cup is rigidly affixed to an upstanding tube 244. The upper end of this tube 244 is of frusto-conical configuration and is formed with vents 246. The upper end of the tube 244 is adapted to seat against the lower end of a vertical passage 248 centrally formed in the piston element 215. The interior of this tube 244 is in communication with the upper surface of the diaphragm 212a by means of a smaller tube 250 and a passage 252 formed through the head 211. A coil compression spring 254 normally biases the cup 240 and hence the upper end of the tube 244 downwardly. The interior of the cylindrical cavity 209 is in communication with the annular space 232 by passages 256 formed in the stem 207. The underside of the cup 240 is vented to atmosphere by a vent 248 formed through the lower portion of the body 201. With this arrangement, the spring 254 will force the cup 240 and hence the upper end of the tube 244 downwardly when the vacuum existing within the stem cavity 209 falls to a predetermined value, i.e. when the engine's throttle is opened from its deceleration position. Atmospheric pressure will then be immediately admitted to the upper surface of the diaphragm 212a and the latter will accordingly tend to snap downwardly to its solid outline position of Figures 10 and 11.

From the foregoing description of the regulator valve R it will be apparent that during engine conditions other than deceleration, the valve 207a and hence its piston element 215, will be disposed in a lowermost position. The interior of the air fuel shut-off member will at this time be in communication with the atmosphere through conduit 29, passage 230 and the upper interior of the regulator valve R. When, however, the engine undergoes deceleration, the valve 207a will move to its upper position and the interior of the shut-off member will be placed in communication with the intake manifold vacuum through conduits 28 and 29 and the interior of the regulator valve R.

It will be apparent that various other changes and modifications may be made with respect to the foregoing description without departing from the spirit of the invention or the scope of the following claims.

I claim:

1. Fuel shut-off apparatus for use with an internal combustion engine having an intake manifold, comprising: passage means for conducting idling fuel to the interior of said intake manifold, said passage means normally being open; means for blocking the flow of fuel through said passage means during deceleration of said engine; and means for momentarily introducing more fuel into said intake manifold after a deceleration period than is required to support normal idling of said engine.

2. Fuel shut-off apparatus for use with an internal combustion engine having carburetor means and an intake

manifold connected to said carburetor means, comprising: passage means connecting the interior of said intake manifold with said carburetor means for conducting idling fuel to the interior of said intake manifold; a plug movable between an opened and a closed position for controlling the flow of fuel through said passage means; means for automatically moving said plug from its open to its closed position during deceleration of said engine; and means operable when said plug is moved from its closed to its open position for momentarily introducing more fuel into said intake manifold than is required to support normal idling of said engine, so as to permit a smooth recovery of said engine after a deceleration period.

3. Fuel shut-off apparatus for use with an internal combustion engine having an intake manifold, comprising: passage means for conducting idling fuel to the interior of said intake manifold; a plug movable between an opened and a closed position for controlling the flow of fuel through said passage means, said plug normally being maintained in its open position; and means for automatically moving said plug from its normally open to its closed position during deceleration of said engine, said means permitting said plug to move from said open to said closed position faster than from said closed to said open position so as to momentarily introduce more fuel into said intake manifold than is required to support normal idling of said engine after a deceleration period.

4. Fuel shut-off apparatus for use with an internal combustion engine having an intake manifold, comprising: passage means for conducting idling fuel to the interior of said intake manifold; a plug movable between an open and a closed position for controlling the flow of fuel through said passage means, said plug normally being maintained in said open position; means operatively connected to said plug for automatically moving it from its normally open to its closed position during deceleration of said engine; and dashpot means operatively connected to said plug so as to permit it to move from its open to its closed position at a faster rate of speed than from its closed to its open position and to thereby momentarily introduce more fuel into said intake manifold after a deceleration period than is required to support normal idling of said engine.

5. Fuel shut-off apparatus for use with an internal combustion engine having carburetor means and an intake manifold connected to said carburetor means, comprising: passage means connecting said carburetor means and said intake manifold for conducting idling fuel into the latter, said passage means terminating in an opening communicating with the interior of said intake manifold; a plug movable relative to said opening so as to control the flow of fuel therethrough, said plug normally being maintained in an open position; means for automatically moving said plug from its normally open to its closed position during deceleration of said engine; and means operable when said plug is moved from its closed to its open position after a deceleration period for momentarily introducing more fuel into said intake manifold than is required to support normal idling of said engine.

6. Fuel shut-off apparatus as set forth in claim 5 wherein said plug is movable away from the wall wherein said opening is formed as it moves from its closed to its open position whereby said plug tends to draw fuel through said opening.

7. Fuel shut-off apparatus for use with an internal combustion engine having an intake manifold and a carburetor, comprising: passage means connecting said carburetor means and the interior of said intake manifold for conducting idling fuel into the latter, said passage means terminating in an opening communicating with the interior of said intake manifold; a plug movable relative to said opening so as to control the flow of fuel therethrough, said plug normally being maintained in an

11

open position and said plug being movable away from the wall wherein said opening is formed as it moves from its closed to its open position whereby it tends to draw fuel through said opening; means for automatically moving said plug from its open to its closed position during deceleration of said engine; and means operable when said plug is moved from its closed to its open position after a deceleration period for momentarily introducing more fuel into said intake manifold than is required to support normal idling of said engine so as to permit smooth recovery of said engine after a deceleration period.

8. Fuel shut-off apparatus for use with an internal combustion engine having carburetor means and an intake manifold, comprising: passage means connecting said carburetor means and the interior of said intake manifold for conducting idling fuel into the latter, said passage means terminating in an opening communicating with the interior of said intake manifold; a plug movable relative to said opening so as to control the flow of fuel therethrough, said plug normally being maintained in an open position and said plug being movable away from the wall wherein said opening is formed as it moves from its closed to its open position whereby it tends to draw fuel through said opening; and means for automatically moving said plug from its normally open to its closed position during deceleration of said engine, said means permitting said plug to move from its open to its closed position faster than from its closed to its open position so as to momentarily introduce more fuel into said intake manifold after a deceleration period than is required to support normal idling of said engine.

9. Fuel shut-off apparatus for use with an internal combustion engine having carburetor means and an intake manifold, comprising: passage means connecting said carburetor means and the interior of said intake manifold for conducting idling fuel into the latter, said passage means terminating in an opening communicating with the interior of said intake manifold; a plug movable relative to said opening so as to control the flow of fuel therethrough, said plug normally being maintained in an open position and said plug being movable away from the wall wherein said opening is formed as it moves from its closed to its open position whereby it tends to draw fuel through said opening; means for automatically moving said plug from its open to its closed position during deceleration of said engine; and dashpot means operatively connected to said plug so as to permit it to move from its open to its closed position at a faster rate of speed than from its closed to its open position so as to momentarily introduce more fuel into said intake manifold after a deceleration period than is required to support normal idling of said engine so as to permit smooth recovery of said engine after a deceleration period.

10. Fuel shut-off apparatus for use with an internal combustion engine having a carburetor and an intake manifold, comprising: passage means connecting said carburetor means and the interior of said intake manifold for conducting idling fuel into the latter, said passage means terminating in an opening communicating with the interior of said intake manifold; a shut-off member mounted adjacent said opening and including a metering pin movable between a normally open position and a closed position; a plug formed on said metering pin cooperating with said opening for controlling the flow of fuel therethrough into said intake manifold; a metering chamber formed in said shut-off member communicating with said opening and forming a portion of said passage means; a stopper element formed on said metering pin and disposed within said metering chamber so as to control the flow of fuel into said opening, said stopper element blocking flow into said opening when said metering pin is in its fully open position; by-pass means formed in said metering pin for conducting idling fuel from said metering chamber into said opening when said meter-

12

ing pin is disposed in its fully open position; and automatic means for moving said metering pin from its normally open to its closed position during deceleration of said engine and re-opening said plug after a deceleration period, said means permitting said metering pin to move from said open to said closed position faster than from said closed to said open position so as to permit said stopper element to momentarily introduce more fuel into said intake manifold from said metering chamber than is required to support normal idling of said engine.

11. Fuel shut-off apparatus for use with an internal combustion engine having a carburetor and an intake manifold, comprising: passage means connecting said carburetor and the interior of said intake manifold for conducting idling fuel into the latter, said passage means terminating in an opening communicating with the interior of said intake manifold; a plug movable relative to said opening so as to control the flow of fuel therethrough, said plug normally being maintained in an open position; a fuel storage chamber communicating with said opening; means for filling said storage chamber while said plug is in its closed position; means for moving said plug from its closed to its open position at the end of a deceleration period; and means for permitting the fuel in said storage chamber to be introduced into said intake manifold as said plug moves from its closed to its open position after a deceleration period so as to momentarily supply said engine with more fuel than is required to support its normal idling.

12. Fuel shut-off apparatus for use with an internal combustion engine having a carburetor and an intake manifold, comprising: passage means connecting said carburetor and the interior of said intake manifold for conducting idling fuel into the latter, said passage means terminating in an opening communicating with the interior of said intake manifold; a shut-off member mounted adjacent said opening and including a metering pin movable between a normally open position and a closed position; a plug formed on said metering pin and cooperating with said opening for controlling the flow of fluid therethrough into said intake manifold; a fuel storage chamber formed in said shut-off member and communicating with said opening; and a piston formed on said metering pin and slidably disposed within said fuel storage chamber so as to enlarge the volume thereof as said metering pin is moved from an open to a closed position whereby said storage chamber may be filled with fuel, said piston forcing fuel out of said storage chamber into said opening as said metering pin is moved from a closed to an open position so as to momentarily supply said engine with more fuel than is required to support its normal idling.

13. Fuel shut-off apparatus for use with an internal combustion engine having carburetor means and an intake manifold connected to said carburetor means, comprising: passage means connecting said carburetor means and said intake manifold for conducting idling fuel into the latter, said passage means terminating in an opening communicating with the interior of said intake manifold; a plug movable relative to said opening so as to control the flow of fuel therethrough, said plug normally being maintained in an open position; means responsive to the value of the intake manifold vacuum for automatically moving said plug from its normally open to its closed position during deceleration of said engine; means operable when said plug is moved from its closed to its open position after a deceleration period for momentarily introducing more fuel into said intake manifold than is required to support normal idling of said engine; and a pressure regulator member connected to said intake manifold for venting its interior to the atmosphere at a predetermined value of intake manifold vacuum.

14. Fuel shut-off apparatus for use with an internal combustion engine having an intake manifold, comprising: passage means for conducting idling fuel to the in-

13

terior of said intake manifold; a plug movable between an opened and a closed position for controlling the flow of fuel through said passage means, said plug normally being maintained in its open position; means responsive to the value of the intake manifold vacuum for automatically moving said plug from its normally open to its closed position during deceleration of said engine, said means permitting said plug to move from said open to said closed position faster than from said closed to said open position so as to momentarily introduce more fuel into said intake manifold after a deceleration period than is required to support normal idling of said engine; and a pressure regulator member connected to said intake manifold for venting its interior to the atmosphere at a predetermined value of intake manifold vacuum.

15. Fuel shut-off apparatus for use with an internal combustion engine having an intake manifold and a carburetor, comprising: passage means connecting said carburetor and the interior of said intake manifold for conducting idling fuel into the latter, said passage means terminating in an opening communicating with the interior of said intake manifold; a plug movable relative to said opening so as to control the flow of fuel therethrough, said plug normally being maintained in an open position, said plug being movable away from the wall wherein said opening is formed as it moves from its closed to its open position; means responsive to the value of the intake manifold vacuum for automatically moving said plug from its open to its closed position during deceleration of said engine; means operable when said plug is moved from its closed to its open position after a deceleration period for momentarily introducing more fuel into said intake manifold than is required to support normal idling of said engine so as to permit smooth recovery of said engine after a deceleration period; and a pressure regulator member connected to said intake manifold for venting its interior to the atmosphere at a predetermined value of intake manifold vacuum.

16. Fuel shut-off apparatus for use with an internal combustion engine having a carburetor and an intake manifold, comprising: passage means connecting said carburetor and the interior of said intake manifold for conducting idling fuel into the latter, said passage means terminating in an opening communicating with the interior of said intake manifold; a shut-off member mounted adjacent said opening and including a metering pin movable between a normally open position and a closed position; a plug formed on said metering pin cooperating with said opening for controlling the flow of fuel therethrough into said intake manifold; a metering chamber formed in said shut-off member communicating with said opening and forming a portion of said passage means; a stopper element formed on said metering pin and disposed within said metering chamber so as to control the flow of fuel into said opening, said stopper element blocking flow into said opening when said metering pin is in its fully open position; by-pass means formed in said metering pin for conducting idling fuel from said metering chamber into said opening when said metering pin is disposed in its fully open position; automatic means responsive to the value of the intake manifold vacuum for moving said metering pin from its normally open to its closed position during deceleration of said engine and re-opening said plug after deceleration period, said means permitting said metering pin to move from said open to said closed position faster than from said closed to said open position so as to permit said stopper element to momentarily introduce more fuel into said intake manifold from said metering chamber than is required to support normal idling of said engine; and a pressure regulator member connected to said intake manifold for venting its interior to the atmosphere at a predetermined value of intake manifold vacuum.

17. Fuel shut-off apparatus for use with an internal combustion engine having a carburetor and an intake

14

manifold, comprising: passage means connecting said carburetor and the interior of said intake manifold for conducting idling fuel into the latter, said passage means terminating in an opening communicating with the interior of said intake manifold; a plug movable relative to said opening so as to control the flow of fuel therethrough, said plug normally being maintained in an open position; a fuel storage chamber communicating with said opening; means for filling said storage chamber while said plug is in its closed position; means responsive to the value of the intake manifold vacuum for moving said plug from its closed to its open position at the end of a deceleration period; means for permitting the fuel in said storage chamber to be introduced into said intake manifold as said plug moves from its closed to its open position after a deceleration period so as to momentarily supply said engine with more fuel than is required to support its normal idling; and a pressure regulator member connected to said intake manifold for venting its interior to the atmosphere at a predetermined value of intake manifold vacuum.

18. Fuel shut-off apparatus for use with an internal combustion engine having an intake manifold and a carburetor, the latter including a throat wherein is disposed a throttle valve, said throttle valve being movable between an open position and a closed position, comprising: passage means connecting said carburetor means and said intake manifold for conducting idling fuel into the latter, said passage means terminating in an opening communicating with the interior of said intake manifold; a shut-off member formed with an inlet passage aligned with said opening; a plug carried by said shut-off member and movable relative to said opening so as to control the flow of fuel therethrough, said plug normally being maintained in open position relative to said opening, said plug being movable away from said opening towards the confines of said intake manifold as it moves from its closed to an open position relative to said opening whereby it tends to draw fuel through said opening; and means for automatically moving said plug from its open to its closed position during deceleration of said engine.

19. Fuel shut-off apparatus for use with an internal combustion engine having a carburetor and an intake manifold, comprising: passage means connecting said carburetor means and the interior of said intake manifold for conducting idling fuel into the latter, said passage means terminating in an opening communicating with the interior of said intake manifold; a shut-off member mounted adjacent said opening and including a metering pin that extends through said opening, said metering pin being movable between a normally open position and a closed position; a plug formed on the portion of said metering pin that extends through said opening, said plug seating against said opening when said metering pin is in its closed position and said plug being movable away from said opening towards the confines of said intake manifold as said metering pin moves towards its open position whereby it tends to draw fuel through said opening; and means for automatically moving said metering pin from its open to its closed position during deceleration of said engine.

20. Fuel shut-off apparatus for use with an internal combustion engine having an intake manifold, comprising: first passage means for conducting idling fuel towards the interior of said intake manifold, said passage means normally being open; first blocking means for blocking the flow of fuel through said first passage means during deceleration of said engine, the operation of said blocking means being responsive to the value of the intake manifold vacuum; second passage means to vent the interior of said intake manifold to the atmosphere; second blocking means normally closing said second passage means, but not closing said first passage means; and means operatively connected to said second blocking means causing it to open said second passage means at a higher

15

value of intake manifold vacuum than that at which said first blocking means is actuated to block the flow of fuel through said first passage so as to thereby prevent rough operation of said engine after the flow of fuel through said first passage means is resumed.

21. Fuel shut-off apparatus as set forth in claim 20 wherein the operation of said last-mentioned means is responsive to the value of the intake manifold vacuum.

22. Fuel shut-off apparatus for use with an internal combustion engine having an intake manifold, comprising: 10
first passage means for conducting idling fuel towards the interior of said intake manifold, said passage means normally being open; first blocking means for blocking the flow of fuel through said first passage means during deceleration of said engine, the operation of said first blocking 15
means being responsive to the value of the intake manifold vacuum; second passage means to vent the interior of said intake manifold to the atmosphere; second blocking means normally closing said second passage 20
means, but not closing said first passage means; means for momentarily introducing more fuel into said intake

16

manifold after a deceleration period that is required to support normal idling of said engine; and means operatively connected to said second blocking means causing it to open said second passage means at a higher value 5
of intake manifold vacuum than that at which said first blocking means is actuated to block the flow of fuel through said first passage so as to thereby prevent rough operation of said engine after the flow of fuel through said first passage means is resumed.

23. Fuel shut-off apparatus as set forth in claim 22 wherein the operation of said last-mentioned means is responsive to the value of the intake manifold vacuum.

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