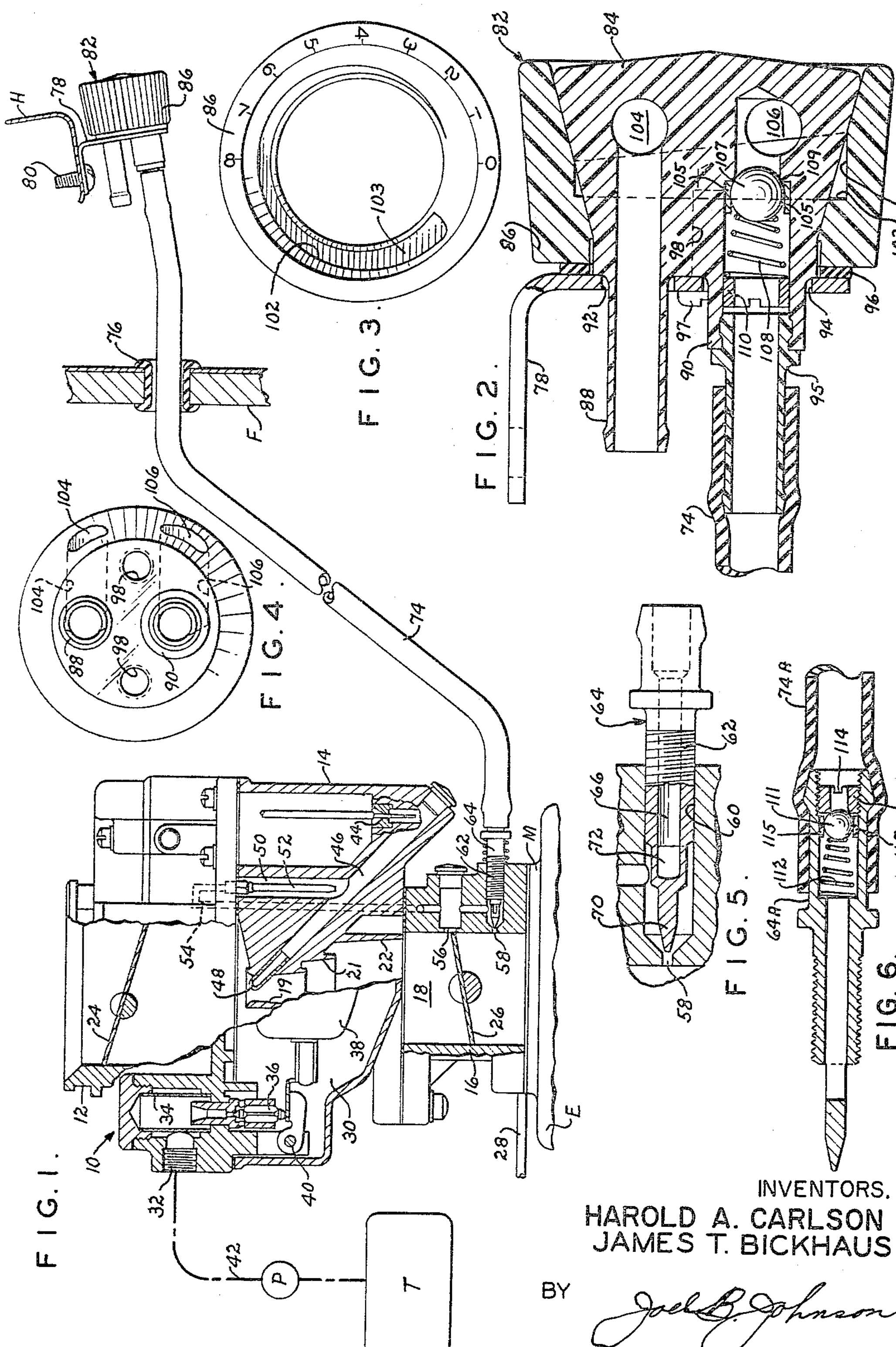
April 11, 1967 H. A. CARLSON ETAL 3,313,532

ANTI-SMOG DEVICE

Filed Jan. 22, 1965 4 Sheets-Sheet 1



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ANTI-SMOG DEVICE

Filed Jan. 22, 1965 4 Sheets-Sheet 2

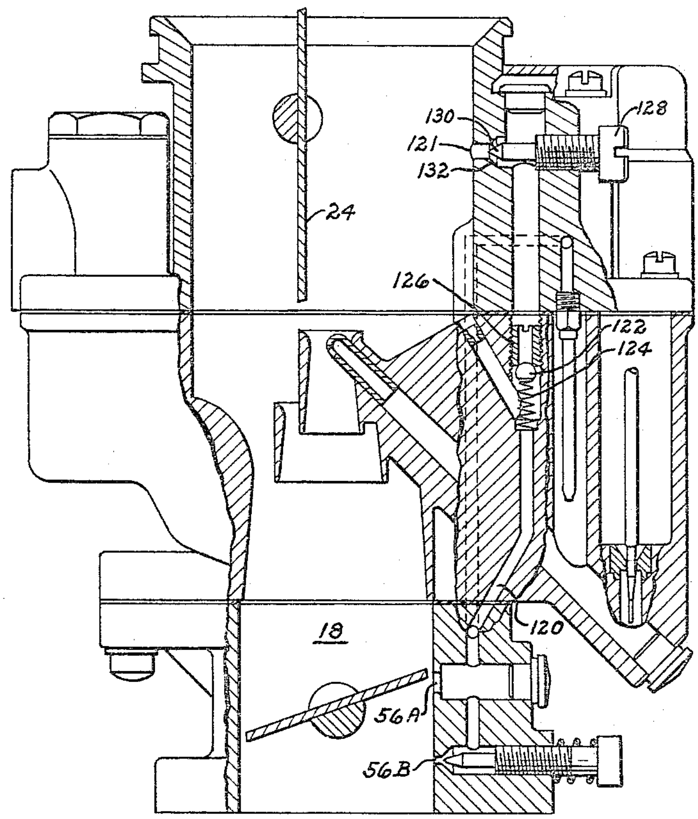

FIG. 8.

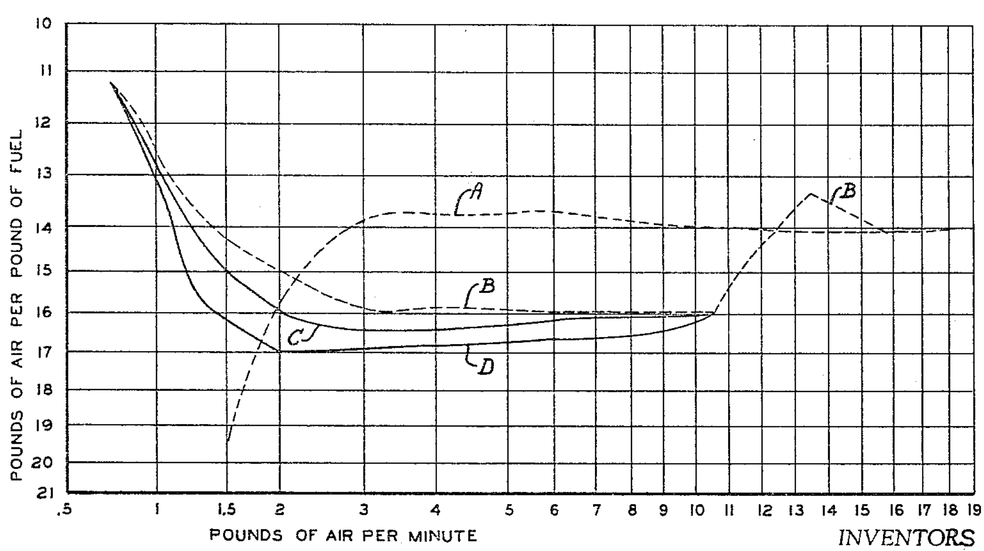

FIG. 7.

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ANTI-SMOG DEVICE

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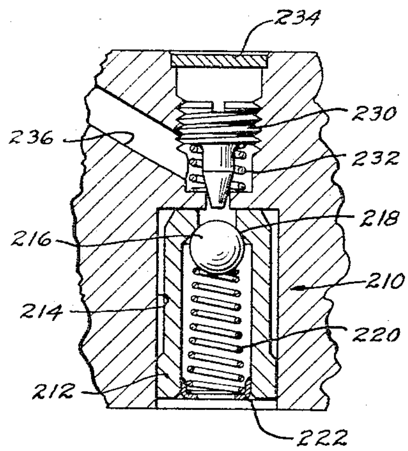

FIG. 11.

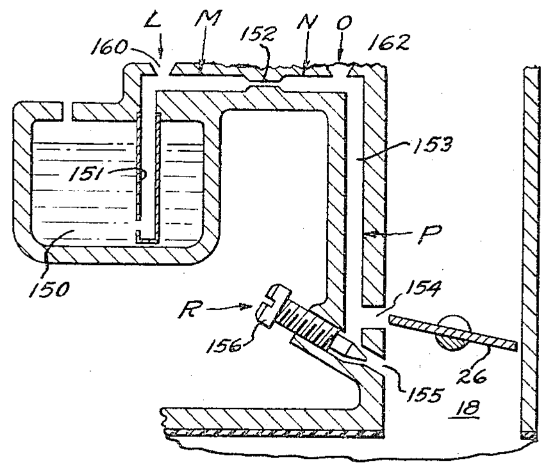

FIG. 9.

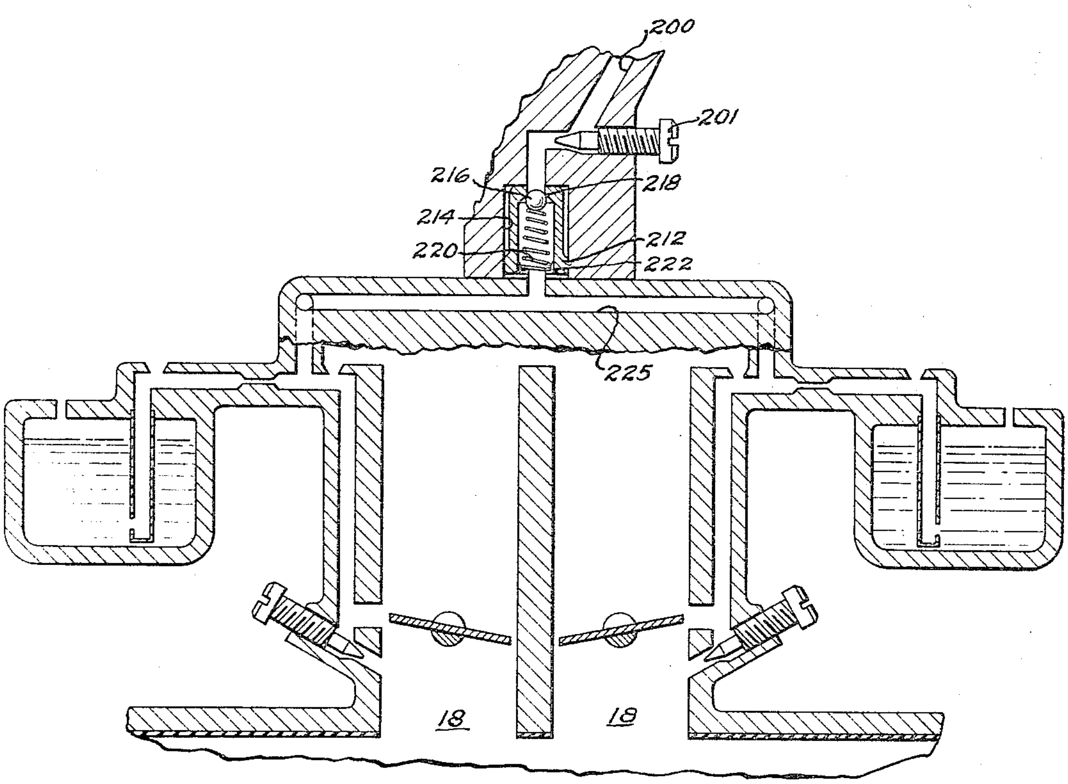

FIG. 10.

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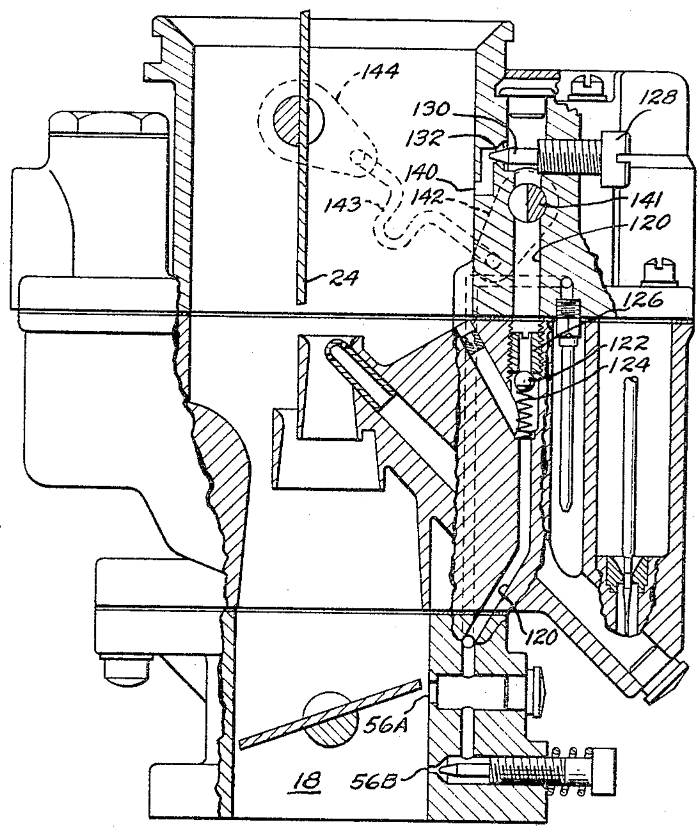

FIG. 13.

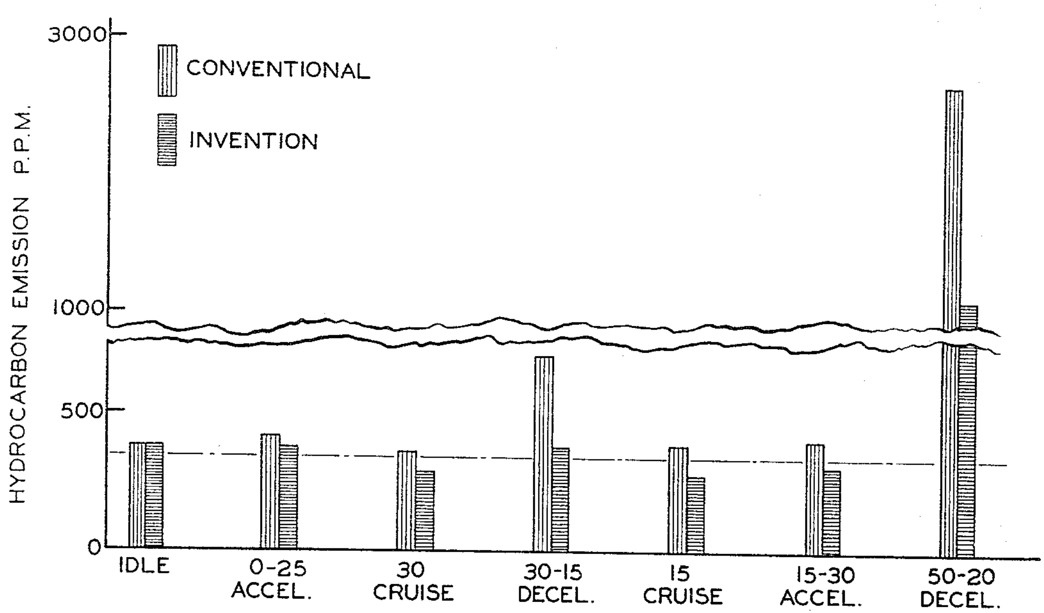

FIG. 12.

United States Patent Office

3,313,532
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3,313,532

ANTI-SMOG DEVICE

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Filed Jan. 22, 1965, Ser. No. 432,050
12 Claims. (Cl. 261—39)

This is a continuation in part of our copending application Ser. No. 394,786 filed Sept. 8, 1964, and now abandoned.

This invention relates to a carburetor for internal combustion engines. In one of its aspects, the invention relates to means for controlling the air and fuel mixture in a carburetor. In another of its aspects, the invention relates to means for controlling the air and fuel mixture in the idling system as the throttle is moved between closed and opened positions in part throttle ranges. In another aspect, the invention relates to an anti-smog device for use in automotive carburetors.

The idling system in a carburetor supplies a small quantity of an air and fuel mixture to keep the engine running when the throttle is closed or nearly closed. As the throttle is opened, an increased suction is applied to the idling system and more fuel is supplied thereby. An increased suction is likewise applied to the main fuel discharge nozzle as the throttle is opened and fuel is discharged therefrom with a gradual reduction in discharge from the idle system until the discharge is negligible. The discharge from the idling system when transferring to the main discharge system as the throttle is being opened or when the throttle remains only partly open is normally overenriched as the idling system is calibrated at one specific position.

Various devices have been previously employed to correct this overenrichment in the idle system as the throttle is being moved to wide open position by the bleeding in of air to the idling system. An example of these prior devices is illustrated in U.S. Patent 2,209,511 issued July 30, 1940, and shows a carburetor having an air bleed valve which opens at a predetermined vacuum in the idling system to bleed air in the idling system for leaning out the mixture, and closes at a predetermined vacuum to block the flow of air being bled in the idling system. Another example of the prior devices is illustrated in U.S. Patent 3,077,341 issued Feb. 12, 1963, in which both a vacuum controlled air bleed valve and a temperature control air bleed valve are provided. Upon a predetermined temperature being reached a temperature responsive control is actuated to bleed air in the idle port for leaning out the mixture. Likewise, upon a predetermined vacuum being reached, a vacuum controlled air bleed valve is opened to lean out the mixture.

Overenrichment of the fuel system of a carburetor can and has brought about undesirable results. A simple overenrichment results in a waste of fuel and thus a loss in economy of operation. More importantly, in recent years the presence of unburned hydrocarbons in the exhaust gases from automobile engines have been found to contribute to an undesirable atmospheric condition more commonly called "smog." The exact nature of smog is not fully understood, but it is known that where the proper atmospheric conditions exist for the formation of smog, there are found substantial amounts of unburned hydrocarbons and of carbon monoxide in the air. Any overenrichment of the fuel system of an automobile engine can contribute to the discharge of these undesirable constituents into the atmosphere. Too rich a fuel mixture may easily result in incomplete burning which in turn will result in the discharge of unburned hydrocarbons and incomplete combustion of others to produce carbon monoxide. Calibration and adjustment of a carburetor

for a particular operating condition is not an overly difficult task. For this particular condition it is possible to adjust a carburetor to give good economy and also minimize the discharge of undesirable constituents into the atmosphere. The problem becomes more complex when it is necessary to construct carburetors to operate over a wide range of conditions and the problem is further magnified by the individual driving habits of motor vehicle operators.

In present day automotive carburetors the only adjustment normally available to a mechanic is the idle fuel needle screw. Ordinarily, the needle adjustment is set to give smooth operation at curb idle. If the adjustment of the idle mixture control gives an incorrect mixture for some other flow rate such as part throtle operation, there is little further adjustment that can be made.

Except for the idle adjustment, all other restrictions in the flow passages of the fuel in the carburetor are normally set at the factory and are, of course, accurate within factory tolerances. In recent years, there has been a concerted effort to narrow the range of factory tolerances, but this is not an easy task. When fuel air ratio tests are made, it has been found that at various flow rates of air through the carburetor there is a variation due to factory tolerances from one carburetor to the next and this variation may also contribute to the formation of smog. It has been discovered that where there is possible an adjustment of the idle fuel system other than that at curb idle, the factory tolerance range can be substantially lessened and a higher percentage of the carburetors will fall on the curve which represents optimum fuel air ratio for each condition of part throtle operation. It has also been found that the closer a carburetor approaches optimum fuel air ratio, the less tendency to produce smog forming constituents when the carburetor is operated on an automotive vehicle. We have discovered that when additional air is bled into the idle fuel system at flow rates above curb idle, the fuel air ratio can be controlled more closely and a substantial reduction in the amount of unburned hydrocarbons can be realized. We achieve this result by use of an automatic air bleed valve, or mixture control device in the idle fuel system which opens only after the throttle has moved away from the fully closed or idle position. The quantity of air thus admitted can be manually controlled as by a knob on the dash of the automobile, or it can be factory set, or it can be arranged for adjustment by a mechanic.

The present invention relates to an improvement over previous devices in the provision of means for bleeding a quantity of air in the idling system upon the opening of an air bleed valve at a predetermined minimum vacuum in the idling system only slightly above the vacuum at curb idle. The air bleed valve is set to open at a vacuum at the idle port between around 7 and 12 inches of water which is slightly above the vacuum at curb id'e. If the rate of acceleration reaches a certain maximum the vacuum at the idle port will drop below around 7 to 12 inches of water and will result in the seating of the air bleed valve and the enrichment of the air and fuel mixture which is desirable for a high rate of acceleration. Thus, the present invention is particularly applicable for part throttle operating conditions below a certain maximum rate of acceleration.

A further feature of this invention is the provision of a control means for selectively metering the quantity of air bled in the idling system upon the opening of the air bleed valve. Such a control means may be manually operated and easily set manually for a predetermined flow of air through the idle system to provide an optimum air and fuel mixture without overenrichment. Engine requirements vary among different vehicles and different ambient conditions, and the present manual control means permits the flow of air to be varied to meet these varying requirements. The present manual control may be positioned on the dashboard of an automobile within easy accessibility of the driver and may be easily rotated to adjust the flow of air bled in the idling system upon opening of the air bleed valve.

An object of this invention is to provide a carburetor with an air bleed valve in the idling system which is opened at a vacuum in the idling system only slightly above the vacuum at curb idle and may be adjusted for seating at a preselected vacuum in the idling system.

An additional object of the present invention is to provide a carburetor with means for controlling the amount of air bled in the idling system upon movement of the throttle to partly open position.

A further object of this invention is to provide a carburetor having means to permit bleeding of air in the idle system at a predetermined vacuum in the idle system at a predetermined vacuum in the idle system, and means to control, selectively, the flow of air bled in the idle system when the predetermined vacuum is reached.

Another object is the provision of a manual control means for controlling the air bled in the idle system which control means is easily accessible and may be adjusted periodically as desired to vary the amount of air bled in the idle system.

Yet another object of the invention is the provision of means for controlling air bleed in the idle fuel system of a carburetor whereby hydrocarbon emissions from the exhausts of the automobile will be reduced.

Still another object of the invention is the provision of means for adjusting a carburetor at part throttle to maintain more accurate manufacturing tolerance.

Briefly, this invention comprises a carburetor for an internal combustion engine having a throttle valve in a mixture conduit with an idle port opening into the mixture conduit adjacent the throttle valve, an air passageway connecting the idle port to atmosphere, air bleed valve in said passageway responsive to a vacuum at the idle port being opened at a vacuum slightly greater than the vacuum at the idle port at curb idle thereby to permit air to be bled in for leaning out the air-fuel mixture, and an air bleed control means in the passageway upstream of the air bleed valve to meter the flow of air bled in the passageway when the bleed valve is open, the control means being adjustable to vary, selectively, the volume of air bled in the air passageway when the bleed valve is opened at said predetermined vacuum.

The invention accordingly comprises the constructions hereinafter described, the scope of the invention being indicated in the following claims.

In the accompanying drawings, in which several of various possible embodiments of the invention are illustrated,

FIGURE 1 is a vertical section, partly in side elevation showing a carburetor provided with an idle fuel system for controlling the bleeding in of air and embodying features of the invention;

FIGURE 2 is an enlarged sectional view of manual means for selectively adjusting the amount of air to be bled in the idle fuel system and adapted for mounting adjacent the dash board of an automobile;

FIGURE 3 is a top plan of the outer rotatable portion of the manual means in FIGURE 2 shown removed from the remainder of the manual means;

FIGURE 4 is a bottom plan of the inner portion of the manual means of FIGURE 2 shown removed from the remainder of the manual means;

FIGURE 5 is an enlarged fragment of FIGURE 1 showing the idle adjusting screw;

FIGURE 6 is a view of a modified idle adjusting screw in which a ball check valve is provided for bleeding air in the idle system;

FIGURE 7 is a graphical representation to illustrate the effect of the air bled into the idle fuel system; and

FIGURE 8 is a vertical section, partly in side elevation showing a carburetor provided with a modified idle fuel system for controlling the bleeding of air in the idle fuel system.

FIGURE 9 is a schematic of the idle fuel system of a single barrel carburetor.

FIGURE 10 is a schematic of the idle fuel systems of a multi-barrel carburetor.

FIGURE 11 is a detailed view of a check valve and adjustment screw for use in the invention.

FIGURE 12 is a bar graph portraying the reduction and hydrocarbon emission when the invention is used.

FIGURE 13 is a carburetor similar to that of FIGURE 8, but showing a shut-off valve in the air passage.

Referring to the drawings for a better understanding of this invention, a carburetor is illustrated at **10** and includes an air horn section **12**, a main body section **14** and an outlet section **16**. Sections **12**, **14** and **16** form a mixture conduit **18** having a stack of venturis **19**, **21** and **22** in main body section **14**. Carburetor **10** is mounted on the intake manifold M of a conventional internal combustion engine E adapted for use in driving a vehicle.

A conventional choke valve control mechanism which is operable responsive to intake manifold suction and temperature is provided to control the operation of a choke valve **24** provided in the air inlet end of mixture conduit **18**. A throttle valve **26** is disposed in the outlet end of mixture conduit **18** and is connected by means of a suitable linkage **28** to an accelerator pedal for control by the operator of the vehicle.

Main body section **14** has a fuel bowl **30** having a fuel inlet **32** provided with a screen filter **34** and a fuel inlet valve **36**. A float **38** is pivotally mounted at **40** within fuel bowl **30** for actuating valve **36** to maintain a substantially constant fuel level within the bowl. Fuel is supplied to bowl **30** from a fuel tank T by means of a conventional engine operated fuel pump P positioned in a fuel conduit **42** leading to fuel inlet **32**.

A fuel metering orifice **44** leads from fuel bowl **30** to an upwardly inclined main fuel passage **46** having a main fuel nozzle **48** discharging into primary venturi **19**. An idling fuel system is shown as comprising fuel well **50** leading upwardly from main passage **46**. Mounted within fuel well **50** is a metering tube **52** communicating with an idle passage **54** leading to idle ports **56** and **58** in outlet section **16**. Outlet section **16** (see FIGURE 5 also) has an internally threaded passage **60** coaxial with idle port **58** and receives the threaded end portion **62** of an idle adjusting screw **64**.

Referring particularly to FIGURE 5 idle adjusting screw **64** has an axial bore **66** extending through the main body portion of screw **64**. An inner extension **70** of reduced diameter has an eye **72** communicating with bore **66** and forming an air passageway. A flexible tube **74** fits about adjusting screw **64** and passes through a sleeve **76** mounted on the fire wall F of the vehicle. A bracket **78** may be suitably secured by screw **80** to the underside of a dashboard indicated generally at H.

Supported by bracket **78** is a manual air bleed selector knob generally designated **82**. Selector knob **82** comprises a relatively fixed inner body portion **84** and an outer circumferential sleeve portion **86** forming a dial selectively rotated around inner portion **84**. Extending from bores in inner portion **84** are nipples **88** and **90** being received in supporting relation within respective openings **92**, **94**, of bracket **78**. Tube **74** fits about an intermediate nipple **95** which in turn, is received within nipple **90**. A resilient gasket **96** between inner portion **84** and dial **86** permits the dial to turn easily. To secure knob **82** to bracket **78** screws **97** extend through suitable openings in bracket **78** and are threaded within openings **98** of body portion **78** to hold knob **82** against bracket **78**.

To permit air entering inlet nipple **88** from atmosphere to communicate with tube **74**, dial **86** has an inner convolute circumferential groove **102** forming a relatively flat ledge 103 of a varying width as shown in FIGURES 2 and 3. Transverse passage 104 provides communication between groove 102 and inlet nipple 88 while transverse passage 106 communicates outlet nipple 90 with groove 102. Thus, groove 102 acts as an air passage connecting transverse passages 104 and 106 since the outer ends of passages 104 and 106 are spaced from the adjacent wall of dial 86 when both passages are adjacent groove 102. As shown in FIGURE 2, transverse passage 104 is not in communication with groove 102 since groove 102 is not of sufficient height in the position of FIGURE 2 to reach passage 104 and thus tube 74 is shut off from atmosphere. To place passage 104 in communication with passage 106 to permit the bleeding in of air, dial 86 may be rotated or turned relative to inner portion 84. To indicate the specific position of dial 86, the various positions are numbered consecutively as shown in FIGURE 3 by suitable indicia. FIGURE 2 indicates the position of passage 104, 106 in position No. 0. If dial 86 is rotated to position No. 1, a minimum amount of air is bled in the idle system as indicated by curve C in FIGURE 7. As the dial is rotated from position No. 1, passage 104 communicates with groove 102 in a gradually increasing relation until position No. 8 is reached at which a maximum amount of air is bled in line 74 as indicated by curve D in FIGURE 7. The carburetor is normally calibrated for air flow in the idle system as indicated by curve B shown in FIGURE 7 for the partly open position of throttle valve 26.

It is not desirable to have air bled in the idle system at curb idle when the throttle is closed. Thus, ball check valve 107 is biased by coil spring 108 against seat 109 and blocks the flow of air to outlet nipple 95 until opened at a predetermined suction in the idling system. A threaded sleeve 110 forms a seat for spring 108 and may be adjusted to vary the bias of spring 108. Ball valve 107 is set to open at a predetermined vacuum inside the idle fuel passage (see 120 FIGURE 8), such as, for example, 7 to 12 inches of water. At curb idle, a vacuum of around three to four inches of water is exerted inside the idle fuel passage and ball valve 107 is seated at curb idle. Spaced ribs 105 are positioned adjacent ball valve 107 and guide valve 107 in axial movement away from seat 109 upon unseating and toward seat 109 upon seating. Thus, valve 107 is seated uniformly on seat 109.

Dial 86 is set at a predetermined position determined by the engine operating conditions. When throttle valve 26 is fully closed or in curb idle position as shown in FIGURE 1, idle port 58 and a relatively small portion of idle port 56 is exposed to manifold suction downstream of throttle valve 26. This results in a relatively low suction in the idling system so that a small quantity of a very rich mixture is supplied under normal idling conditions. As throttle valve 26 is opened and the engine accelerates, suction in the idling system increases at first and then decreases. Fuel in appreciable quantities is discharged from the idling ports only when the throttle is closed and during the first part of the opening movement. As the suction increases at main nozzle 48, the idling discharge decreases and becomes leaner as the suction at idle ports 56 and 58 drops.

Referring to FIGURE 7, mixture quality curves are shown which are obtained with the use of conventional flow measuring apparatus by plotting under different conditions the richness of mixture supplied by the carburetor in pounds of air per pound of fuel against the rate of flow in pounds of air per minute. Broken line or curve A represents the full throttle curve while broken line B represents the part throttle flow curve.

Curve C represents the air bled in the idle system from inlet 88 when regulating knob 82 is set for its minimum amount of air flow at position No. 1. Curve D represents the air bled in the idle system from inlet 88 when regulating knob 82 is set for a maximum air flow at position No. 8. Intermediate positions of knob 82 result in air flow between curves C and D. Thus, a rich mixture may be obtained by permitting only a relatively small amount of air to be bled in as indicated by curve C. The mixture may be leaned out by permitting a maximum amount of air to be bled in as indicated at curve D.

Operation of the device of FIGURES 1–5 is as follows: Throttle valve 26 is moved from its closed position to partly open or fully open position with dial 86 preset at a position dependent on operating conditions. As throttle valve 26 is opened, a vacuum, such as, for example, 15 inches of mercury, is exerted through mixture conduit 18, and communicated through the idle system to check valve 107 to actuate valve 107 when the predetermined vacuum is reached. Control knob 82 is set for the desired amount of air to be bled in through the idle system and air from atmosphere enters inlet nipple 88 and passes through passage 104, groove 102, passage 106, outlet nipple 95, to idle adjustment screw 64. Air enters mixture conduit 18 through screw 64 and idle ports 56 and 58 to lean out the mixture. With regulating knob 82 properly set, a substantial reduction in fuel is effected to provide fuel economy. Results have been obtained by this invention increasing the mileage as high as 10% per gallon of fuel.

Referring to FIGURE 6, a modified idle needle screw 62A is illustrated in which a ball check valve 111 is biased by coil spring 112 against threaded valve seat 113. Valve seat 113 has a slot 114 in which a screwdriver or the like may be positioned to adjust valve seat 113 and thereby vary the bias of spring 112 and the seating of ball check valve 111. A plurality of ribs 115 guide the movement of valve 111. Check valve 111 is normally set to seat at a vacuum from seven to twelve inches of water. Hose 74A is positioned about idle needle screw 64A and extends to a selector knob as shown in FIGURES 2, 3 and 4, but with check valve 107, spring 108 and sleeve 110 of the selector knob removed. The check valve means positioned in screw 62A thus is employed in lieu of the check valve means in FIGURE 2. If desired, a suitable filter material, such as a plastic foam material, may be suitably positioned about or within nipple 88 to remove foreign matter from the air drawn in nipple 88. Further, in some instances, it may be desirable to employ idle screw 64A without the manual control on the dashboard of the vehicle. In this event, hose 74A may be removed from idle screw 64A.

Referring to FIGURE 8, an embodiment is shown in which air is obtained from mixture conduit 18 upstream of throttle valve 24. Idle ports 56A and 58A communicate through idle passage 120 with air bleed port 121 upstream of throttle valve 24 and opening into mixture conduit 18. A ball check valve 122 is biased by coil spring 124 against a seat formed by threaded sleeve 126. Sleeve 126 may be adjusted to vary the bias of spring 124 and to permit valve 122 to open at a predetermined vacuum. An adjusting screw 128 has a tapered end 130 adapted to move toward and away from seat 132 to adjust the flow of air through port 121. Adjusting screw 128 may be moved to various selected openings to vary the amount of air between a minimum and maximum as in the embodiment shown in FIGURES 1–5.

The carburetor of FIGURE 13 is similar to that of FIGURE 8. Two differences are apparent. The first of these differences is that the air port for supplying additional air to the idle fuel system has been moved to a position below the choke valve when the choke valve is in its closed position. The new position of the idle bleed port is shown at 140. With port 140 below the closed position of the choke valve, air will not enter the automatic idle bleed system until the choke is at least partly open, thus making the automatic air bleed inoperative at least during the early stages of warm-up.

There is also shown in FIGURE 13 a positive means for rendering the automatic air bleed inoperative during warm-up. To accomplish this purpose, a valve member 141 is placed in air bleed passage 120 and connected by means of lever arm 142 connecting link 143 and lever arm 144 to the shaft of choke 24. The automatic choke mechanism is not shown but can be of any conventional type. With the arrangement illustrated, passage 120 is closed until the choke has opened to an angle of about 45° after which the automatic air bleed passage 120 is then opened and free to operate as heretofore described.

In FIGURE 9 there is shown schematically, the idle fuel system of a carburetor. As shown fuel is picked up from a well 150 by tube 151 passed along the fuel passage to an economizer 152 and thence downwardly to idle passage 153 to the idle port 154 and 155. An adjustment screw 156 is provided to adjust the flow of fuel during curb idle conditions. Also shown are two ports at which air can enter the idle fuel passage. The first of these shown at 160 is usually termed "by-pass" air. The second shown at 162 is usually termed "idle bleed" air. The size of all restrictions except the adjustment of the idle adjustment screw described in connection with FIGURE 9 are factory adjustments and normally are not changed once the carburetor is in use.

In accordance with the invention, additional air is injected into the idle fuel system at any one of a number of points in the system. In FIGURE 9 alternate injection points for additional air are designated at the arrows lettered L, M, N, O, P and R. Those lettered N and R correspond to the injection points of FIGURES 8 and 1 respectively.

The idle fuel system shown schematically in FIGURE 10 is similar to that of FIGURE 9 excepting that a multi-barrel carburetor is shown. This could be a two-barrel carburetor or the two primary barrels of a four-barrel carburetor having secondary barrels as well. Excepting for the duplication occasioned by the use of two barrels instead of one, the carburetor of FIGURE 10 is like that of FIGURE 9 with one important exception. In FIGURE 10 the automatic air bleed is shown as entering the idle fuel system at points corresponding to N of FIGURE 9, but only one source of air for both idle systems is used. As shown air from inside the air horn enters by passage 200 and is adjusted in quantity by adjusting screw 201. Air then passes downwardly through a check valve assembly indicated generally at 210. The check valve assembly comprises a housing 212 pressed into a bore 214. Within the housing there is a ball check valve 216 held against a seat 218 by a spring 220. The spring 220 is retained in its position by a retainer 222. Check valve assembly 210 is shown in greater detail in FIGURE 11. Air entering through check valve assembly 210 passes downwardly to a cross passage 225 where it separates into two portions which travel to each of the separate idle fuel systems as shown. In other respects, the system of FIGURE 10 operates substantially the same as that of FIGURE 8 excepting for the fact that there are two separate idle systems. Referring to FIGURE 11, the check valve portion of the automatic air bleed system is shown in detail. A particular feature of the check valve assembly 210 is the provision for adjustment of the compression of spring 220. During manufacture the check valve can be placed in communication with a source of air under pressure or under vacuum as desired, the ball 216, spring 220 and retainer 222 are placed in position. Then with a differential pressure across the assembly, retainer 222 is pressed inwardly until the ball seats and holds tightly at a desired differential but opens to permit passage of air when that differential pressure is exceeded. This permits a very fine and delicate adjustment of the required pressure. Also shown in FIGURE 11 is an air adjustment screw 230 which may be contained within the carburetor body. Screw 230 will be adjusted during manufacture of the carburetor to permit passage of only the desired quantity of air. Screw 230 will be prevented from changing its position by some locking means such as a spring 232. After adjustment of screw 230, the top of the bore may be closed as by plug 234. With such an arrangement air is supplied by way of an air passage 236 which desirably communicates with the interior of the air horn or the interior of the air filter.

Referring now to any of FIGURES 1, 8, 9, 10, or 13, it will be seen that in each instance the throttle valve is closed. In other words, under these conditions, the engine when running will be running under idle conditions. At that time the pressure beneath the throttle valve is very low, usually of the order of 15–18 inches of mercury vacuum. Although, the pressure within the barrel of the carburetor under the throttle valve is very low, very little of this low pressure is transmitted into the idle fuel passage. The reason for this being that the idle adjustment screw and the throttle plate close off much of the communication with the lower portion of the barrel and fuel flows rather slowly through the idel fuel passage. Under these conditions, the idle fuel passage is substantially filled with liquid fuel and it moves at a rate such that there is a substantial pressure drop along the length of the idle fuel passage. This condition changes quickly when the throttle valve is opened part way. At that time, fuel begin to move more rapidly through the idle fuel passage and air enters the idle fuel system through the idle bleed and the bypass air ports (see 162, 160 of FIGURE 9). The pressure within the idle fuel passage that was only about seven to ten inches of water vacuum during the idle operation drops rapidly when the throttle is open so that it quickly becomes less than one inch of mercury vacuum and may under some circumstances become as low as five to ten inches of mercury vacuum. It is desirable that the ball check valve such as check valve 210 of FIGURES 10 and 11, be adjusted to open at a pressure differential only slightly lower than that of normal idle. In other words, if the pressure within the idle fuel passage is normally ten inches of water vacuum, the check valve might be adjusted to open at a pressure of twelve inches of water vacuum. If it is desired that the automatic feature come into play a little later in the operation of the carburetor, the initial opening of the check valve 210 could be delayed until the vacuum has risen to one or even two inches of mercury. In any event, once the check valve has unseated, the additional air admitted by the check valve has the effect of leaning out the mixture by reason of admitting more air to the idle fuel passage.

As mentioned earlier, the use of the automatic adjustable air bleed permits adjustment of the carburetor at the factory to closer tolerances than has heretofore been possible. To this end the caruburetor is adjusted for normal idle operation in the usual and conventional manner and this determines one fixed point on the air fuel ratio curve. Then, under conditions of part throttle operation, when the automatic air bleed of the invention has been brought into play, the air adjustment screw of the invention is adjusted to give still another point on the air fuel ratio curve. By being able to adjust the idle fuel mixture at two different points in the air fuel ratio curve, it is possible to make the carburetor operate throughout the part throttle region within closer tolerances than has heretofore been possible.

The bar graph of FIGURE 12 illustrates the effect of the automatic air bleed on carburetor operation. Various standard procedures have been adapted for the determination of exhaust gas emissions fmrom an automobile. These standards usually involve operating the automobile under a fixed set of conditions such as at idle, under deceleration, under acceleration and under normal cruising speeds. Under each condition of operation the exhaust gases from the automobile are sampled and analyzed for the component parts. The amount of unburned hydrocarbons percent in the exhaust gas is considered by many to be one of the most important factors in the creation of smog. Accordingly, FIGURE 12 shows the quantity of unburned hydrocarbons in the exhaust as part per million. An examination of FIGURE 12 will show that under all conditions of operation excepting that of idle, a conventional carburetor shows a higher unburned hydrocarbon content in the exhaust gas analysis than does the carburetor of the invention. While it might be possible to adjust a conventional carburetor to give satisfactory or permissible levels of unburned hydrocarbons in the exhaust for some one particular condition of operation, this would undoubtedly result in poorer operation at any other condition. For example, a carburetor adjusted to yield a low level of hydrocarbon at a steady cruising speed of thirty miles per hour probably would not give satisfactory performance at curb idle. In face, it is likely that the mixture at curb idle would be so lean that the engine would operate very roughtly or would not run at all. In similar fashion, it would be expected that the engine operating without the invention would give unsatisfactory performance at other conditions of operation if the carburetor were adjusted to give optimum hydrocarbon emission at some steady state conditions such as steady cruising speed.

From the foregoing discussion, it is apparent that we have disclosed an automatic mixture control device which is effective to reduce undesirable constituents in the exhaust of an automobile and which also permits the adjustment of a carburetor to closer tolerances than has heretofore been possible.

Through adjustment of the bias of the spring in the check valve of the invention, it is possible to control the time at which the valve of the invention will be opened. Referring to FIGURE 7, for example, the first point on each of the three mixture curves shown is the fuel air ratio at curb idle conditions. If the spring under the check valve has a very low bias, the valve will open very quickly after the throttle is moved away from the idle condition. For example this would correspond to a point equivalent to one pound air per minute according to the curve of FIGURE 7. By increasing the bias, the opening of the valve can be delayed to a later time such as for example, points corresponding to 1.5, 2 or even 3 pounds of air per minute. Under these conditions the flow curve would follow the curve marked B until such time as the check valve opened after which the curve would shift over to either the curve C, or curve D according to the amount of air being admitted.

From the foregoing, it will be understood that the present invention is an improvement over previous devices, in that a control means is provided for selectively metering the quantity of air bled in the idling system upon actuation of the air bleed valve at a predetermined vacuum in the idling system. Such a control means may be manually operated and easily set at a variety of positions for providing an optimum air and fuel mixture even under different operation conditions. The air bleed valve is set to open at a relatively small vacuum so that the valve is open slightly above the vacuum at curb idle.

In view of the above, it will be seen that the several objects of the invention are achieved and other advantageous results obtained.

As various changes could be made in the above constructions without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. A carburetor for an internal combustion engine comprising a mixture conduit having a downstream end portion adapted to be mounted on an engine intake manifold, a throttle valve in said downstream end portion of the mixture conduit, means forming an idle fuel system in said downstream end portion and including an idle port opening into said mixture conduit, an air passageway connecting said idle port to atmosphere, air bleed valve means in said passageway responsive to vacuum at said idle port, said air bleed valve means being opened at a predetermined vacuum at said idle port to permit air to be bled in said idle port for leaning out the air and fuel mixture and being closed upon a decrease in said vacuum to block the flow of air through said passageway, and air bleed control means upstream of said valve means to meter the flow of air bled in said passageway when said valve means is opened, said control means being adjustable to vary selectively the volume of air being bled in said air passageway when said valve means is opened at said predetermined vacuum.

2. A carburetor for an internal combustion engine as set forth in claim 1 wherein said air bleed control means comprises additional valve means in said air passageway upstream of said air bleed valve means and a manual selector to move said additional valve means between selective open positions for varying the volume of air bled in the air passageway.

3. A carburetor for an internal combustion engine as set forth in claim 1 wherein said air bleed control means comprises additional valve means in said air passageway upstream of said first mentioned air bleed valve means and a selector dial adapted to be positioned on the dashboard of a vehicle, said selector dial being rotatable between selective positions for moving said additional valve means between selective open positions to vary the volume of air bled in the air passageway.

4. A carburetor for an internal combustion engine as set forth in claim 1 wherein a choke valve is positioned in said mixture conduit, said air passageway opening into said mixture conduit through an air port positioned upstream of the choke valve thereby to connect the idle port to atmosphere, and said air bleed control means comprises a metering member mounted adjacent said air port for relative adjustment to control the amount of air flowing through said port.

5. A carburetor for an internal combustion engine comprising a mixture conduit having a downstream end portion adapted to be mounted on an engine instake manifold, a throttle valve in said downstream end portion of the mixture conduit, means forming an idle fuel system in said downstream end portion and including an idle port opening into said mixture conduit, a tapered metering member mounted in the idling system for relative adjustment to control the amount of fuel flowing through the idle port, said metering member having an axial bore, an air passageway from said metering member communicating with said axial bore and connecting the idle port to atmosphere, a check valve in the axial bore of said metering member responsive to vacuum at said idle port and being opened at a predetermined vacuum at said idle port to permit air to be bled in the idle port for leaning out the air and fuel mixture, the check valve being closed upon a decrease in vacuum to block the flow of air through the air passageway and the metering member, and air bleed control means upstream of the check valve to meter the flow of air bled in the passageway when the valve is opened, said control means being adjustable to vary selectively the volume of air being bled in the air passageway when the valve is opened at the predetermined vacuum.

6. A carburetor for an internal combustion engine comprising a mixture conduit having a downstream end portion adapted to be mounted on an engine intake manifold, a throttle valve in said downstream end portion of the mixture conduit, means forming an idle fuel system in said downstream end portion and including an idle port opening into said mixture conduit, an air passageway connecting said idle port to atmosphere, a check valve in said air passageway responsive to vacuum at said idle port and opened at a predetermined vacuum at the idle port to permit air to be bled in the idle port for leaning out the air and fuel mixture, the check valve closing upon a decrease in said vacuum to block the flow of air through said passageway, control means for varying the amount

of air bled in the air passageway upon opening of the check valve, said control means comprising an inner relatively fixed body portion and an outer sleeve portion mounted about the inner body portion for rotation between a plurality of selective positions, said body portion having a pair of bores, one communicating with the atmosphere and the other communicating with the air passageway, and a passage formed between the inner and outer portions communicating the bores in progressively increasing degrees upon rotation of the sleeve portion in one direction thereby to vary selectively the volume of air from atmosphere.

7. A carburetor for an internal combustion engine comprising a mixture conduit having a downstream end portion adapted to be mounted on an engine intake manifold, a throttle valve in said downstream end portion of the mixture conduit, means forming an idle fuel system in said downstream end portion and including an idle port opening into said mixture conduit upstream of the closed position of the throttle valve and a second idle port opening into the mixture conduit downstream of the throttle valve in closed position, a metering member mounted adjacent said second idle port for relative adjustment to control the amount of fuel flowing through said second idle port, an air passageway connecting said idle ports to atmosphere, air bleed valve means in said passageway responsive to a vacuum at said idle ports, said air bleed valve means being opened at a predetermined vacuum at said idle ports to permit air to be bled in said idle ports through said air passageway for leaning out the air and fuel mixture and being closed upon a decrease in said vacuum to block the flow of air through said passageway, and air bleed control means upstream of said valve means to meter the flow of air bled in said passageway when said valve means is opened, said control means being manually adjustable to vary selectively the volume of air being bled in said air passageway when said valve means is opened at said predetermined vacuum.

8. A carburetor for an internal combustion engine comprising:

(A) a mixture conduit having a downstream end portion adapted to be mounted on an engine intake manifold,

(B) a throttle valve in said downstream end portion of the mixture conduit,

(C) means forming an idle fuel system in said downstream end portion and including an idle port opening into said mixture conduit,

(D) an air passageway connecting said idle system to atmosphere,

(E) a ball check valve in said passageway responsive to a vacuum in the idling system and being opened at a vacuum in said passageway above the vacuum at curb idle thereby to be seated at curb idle,

(F) means to adjust the said check valve for opening at a predetermined vacuum slightly above curb idle to permit air to be bled in said idle system for leaning out the air and fuel mixture and being closed upon a decrease in said vacuum to block the flow through said passageway,

(G) blocking valve means in said passageway and means for opening said blocking valve at such time as the engine to which the said carburetor is connected has warmed up.

9. A carburetor for an internal combustion engine comprising:

(A) a mixture conduit having a downstream end portion adapted to be mounted on an engine intake manifold,

(B) a choke valve in an upstream portion of said mixture conduit,

(C) a throttle valve in said downstream end portion of the mixture conduit,

(D) means forming an idle fuel system in said downstream end portion and including an idle port opening into said mixture conduit,

(E) an air passageway connecting said idle system to atmosphere,

(F) a ball check valve in said passageway responsive to a vacuum in the idling system and being opened at a vacuum in said passageway above the vacuum at curb idle thereby to be seated at curb idle,

(G) means to adjust the said check valve for opening at a predetermined vacuum slightly above curb idle to permit air to be bled in said idle system for leaning out the air and fuel mixture and being closed upon a decrease in said vacuum to block the flow through said passageway,

(H) blocking means in said passageway,

(I) and connecting means for connecting said blocking means to said choke valve whereby said blocking means will be opened by said choke valve when said choke valve is opened.

10. A carburetor for an internal combustion engine comprising:

(A) a mixture conduit having a downstream end portion adapted to be mounted on an engine intake manifold,

(B) a choke valve in an upstream portion of said mixture conduit,

(C) a throttle valve in said downstream end portion of the mixture conduit,

(D) means forming an idle fuel system in said downstream end portion and including an idle port opening into said mixture conduit,

(E) an air passageway connecting said idle fuel system to the interior of said mixture conduit at a point below said choke valve,

(F) a ball check valve in said passageway responsive to a vacuum in the idling system and being opened at a vacuum in said passageway above the vacuum at curb idle thereby to be seated at curb idle,

(G) means to adjust the said check valve for opening at a predetermined vacuum slightly above curb idle to permit air to be bled in said idle system for leaning out the air and fuel mixture and being closed upon a decrease in said vacuum to block the flow through said passageway,

(H) blocking means in passageway,

(I) and connecting means for connecting said blocking means to said choke valve whereby said blocking means will be opened by said choke valve when said choke valve is opened.

11. A carburetor for an internal combustion engine comprising:

(A) a mixture conduit having a downstream end portion adapted to be mounted on an engine intake manifold,

(B) a throttle valve in said downstream end portion of the mixture conduit,

(C) means forming an idle fuel system in said downstream end portion and including an idle port opening into said mixture conduit,

(D) an economizer restriction in said idle fuel system,

(E) an air passageway connecting said idle system to atmosphere,

(F) a ball check valve in said passageway responsive to a vacuum in the idling system and being opened at a vacuum in said passageway above the vacuum at curb idle thereby to be seated at curb idle,

(G) means to adjust the said check valve for opening at a predetermined vacuum slightly above curb idle to permit air to be bled in said idle system for leaning out the air and fuel mixture and being closed upon a decrease in said vacuum to block the flow through said passageway,

(H) blocking valve means in said passageway and means for opening said blocking valve at such time as the engine to which the said carburetor is connected has warmed up.

12. A carburetor for an internal combustion engine comprising:

(A) a mixture conduit having a downstream end portion adapted to be mounted on an engine intake manifold,

(B) a choke valve in an upstream portion of said mixture conduit,

(C) a throttle valve in said downstream end portion of the mixture conduit,

(D) means forming an idle fuel system in said downstream end portion and including an idle port opening into said mixture conduit,

(E) an economizer restriction in said idle fuel system,

(F) an air passageway connecting said idle system to atmosphere,

(G) a ball check valve in said passageway responsive to a vacuum in the idling system and being opened at a vacuum in said passageway above the vacuum at curb idle thereby to be seated at curb idle,

(H) means to adjust the said check valve for opening at a predetermined vacuum slightly above curb idle to permit air to be bled in said idle system for leaning out the air and fuel mixture and being closed upon a decrease in said vacuum to block the flow through said passageway,

(I) blocking means in said passageway,

(J) and connecting means for connecting said blocking means to said choke valve whereby said blocking means will be opened by said choke valve when said choke valve is opened.

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