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Woods

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[45] **Mar. 12, 1974**

[54] **AIR VALVE PRESSURE DIAPHRAGM CARBURETOR**

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[22] Filed: **Feb. 26, 1973**

[21] Appl. No.: **335,550**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 175,539, Aug. 27, 1971, abandoned, which is a continuation-in-part of Ser. No. 846,563, July 31, 1969, Pat. No. 3,618,904, which is a continuation-in-part of Ser. No. 822,828, April 9, 1969, Pat. No. 3,556,067, which is a continuation-in-part of Ser. No. 629,488, April 10, 1967, abandoned.

[52] **U.S. Cl.** .... **261/23 A,** 261/23 A, 261/36 A, 261/39 A, 261/39 B, 261/39 C, 261/50 A, 261/67, 261/51, 261/52, 261/78 R, 261/69 A, 261/DIG. 50, 261/DIG. 39

[51] **Int. Cl.** **F02m 7/16**

[58] **Field of Search**.... 261/23 A, 36 A, 39 A, 39 B, 261/39 C, 50 A, 67, 52, 51, 69 A, DIG. 50

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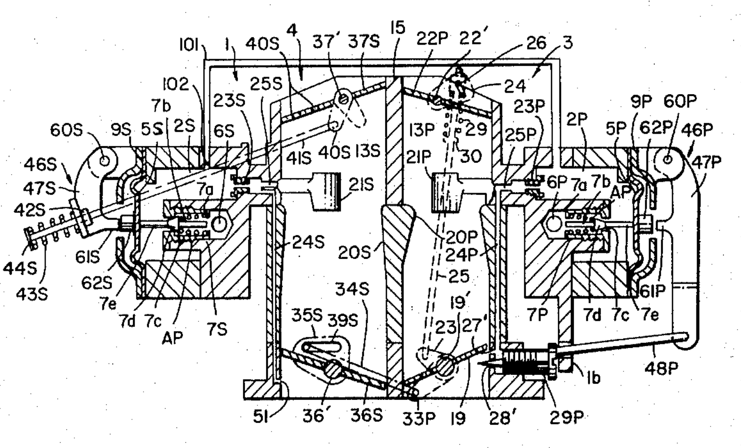
[57] **ABSTRACT**

A carburetor having throttle and air intake valves and a booster ventūri in both the primary and secondary air intake passages.

17 Claims, 7 Drawing Figures



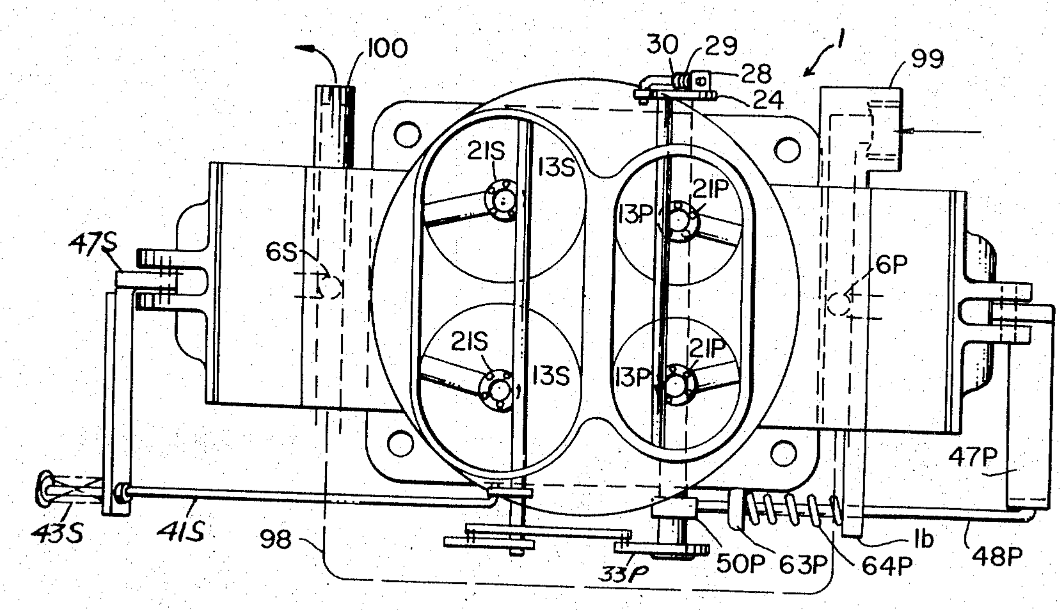

100
30
29
28
24
1
99
21S
13S
21P
13P
47S
6S
6P
21S
13S
21P
13P
47P
43S
41S
98
33P
50P
63P
64P
1b
48P

FIG.1

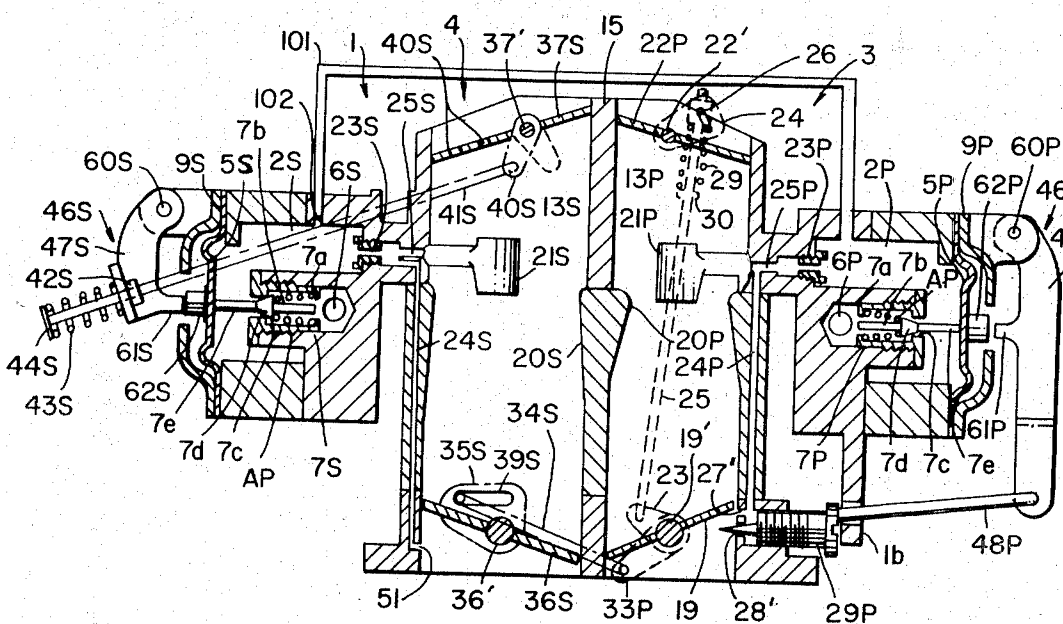

101
1
40S
4
37'
37S
15
22P
22'
26
3
102
25S
24
7b
23S
23P
60S
9S
5S
2S
6S
13P
29
25P
9P
60P
2P
5P
62P
46P
46S
41S
40S
13S
30
47S
21P
21S
6P
7a
7b
47P
42S
7a
AP
20P
44S
61S
24S
20S
24P
43S
62S
25
61P
34S
7e
19'
7P
7d
7c
7e
7d
7c
AP
7S
35S
39S
23
27'
48P
1b
51
36'
36S
33P
19
28'
29P

FIG.2

FIG. 3

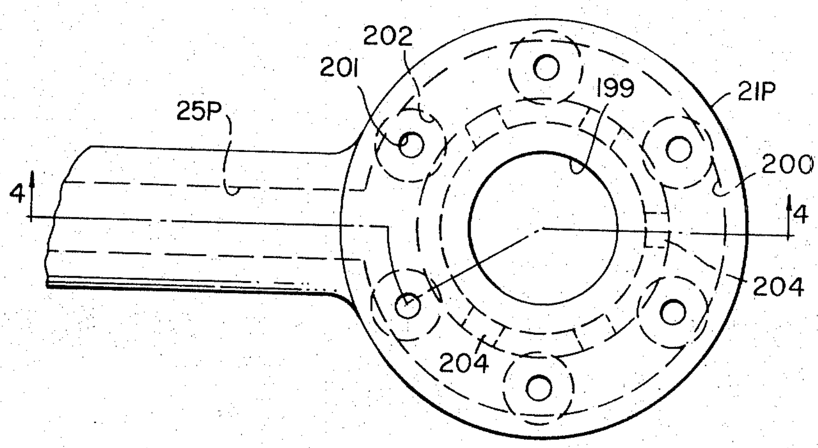
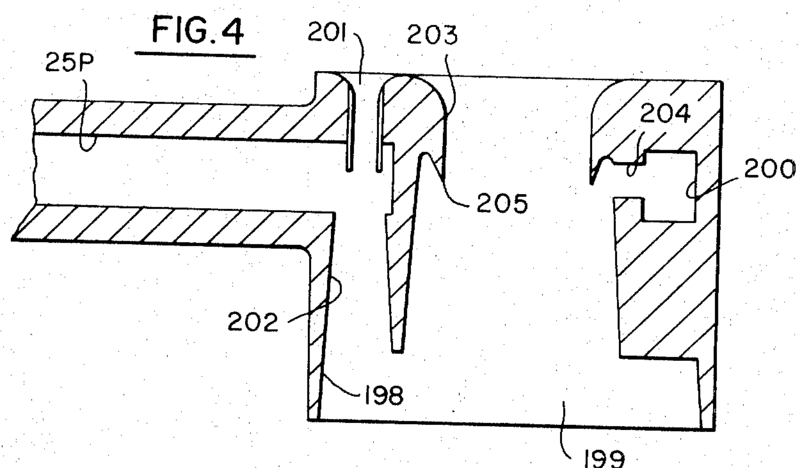


FIG. 4



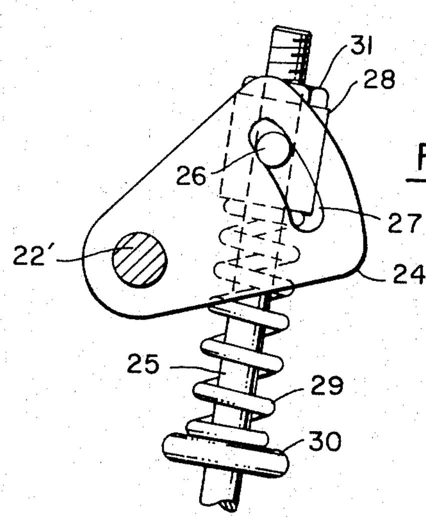


FIG. 5

FIG. 6

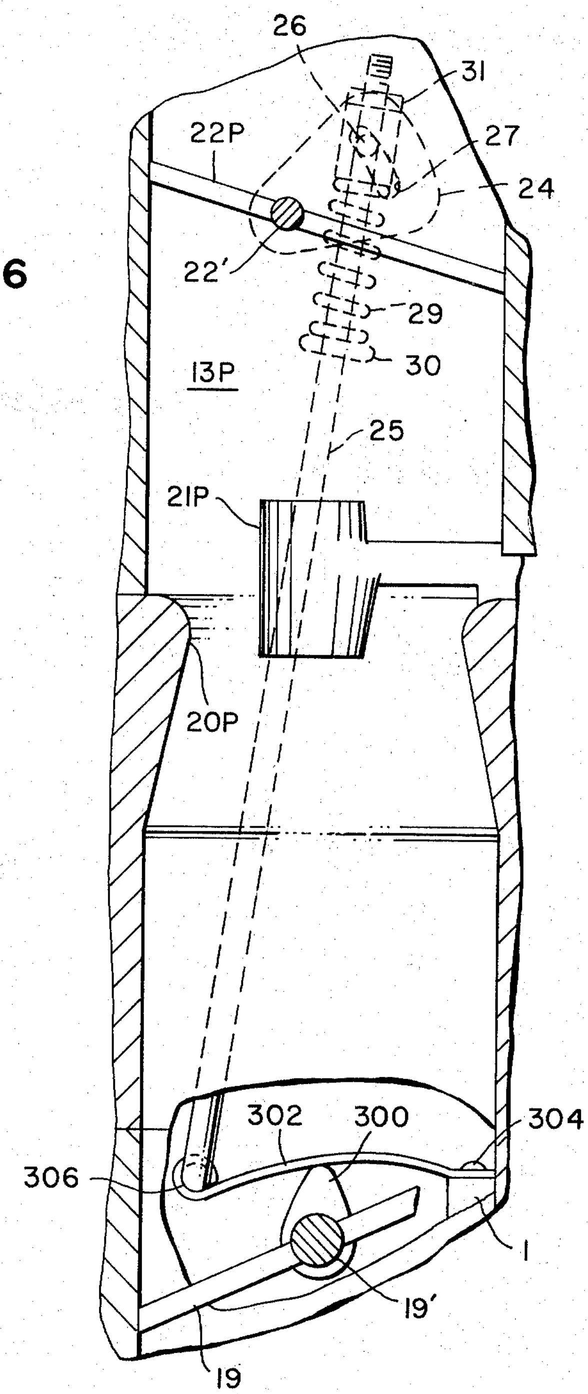
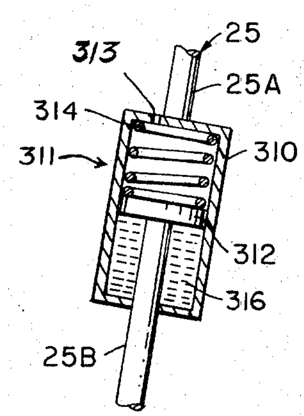

26
31
22P
27
24
22'
29
13P
30
25
21P
20P
302
300
304
306
1
19'
19

FIG. 7


25
313
25A
314
311
310
312
316
25B

AIR VALVE PRESSURE DIAPHRAGM CARBURETOR

REFERENCE TO RELATED APPLICATIONS

This application is a continuation-in-part of my co-pending application, Ser. No. 175,539, filed Aug. 27, 1971, now abandoned, which application, Ser. No. 175,539 is a continuation-in-part of my application, Ser. No. 846,563 filed July 31, 1969 and now U.S. Pat. No. 3,618,904, which application, Ser. No. 846,563 was a continuation-in-part of my application, Ser. No. 822,828, filed Apr. 9, 1969 and now U.S. Pat. No. 3,556,067, which application, Ser. No. 822,828 was a continuation-in-part of my application, Ser. No. 629,488 filed Apr. 10, 1967 and now abandoned.

SUMMARY OF THE INVENTION

One object of this invention is to provide a carburetor designed to accurately control wide-open, part-throttle and idle fuel and air requirements.

Another object is to provide a carburetor designed to minimize hydrocarbon emission with substantially no loss in power or performance and with improved economy.

Another object is to provide a high dispersion booster venturi nozzle which is especially designed to vaporize or break up and disperse fuel entering the air intake passage.

Another object is to provide means for increasing the velocity of air in the air intake passage to achieve better fuel dispersion.

Another object is to provide means for controlling the admission of fuel to the secondary air intake passage designed to prevent premature fuel dumping when the throttle is opened suddenly.

Another object is to provide means for balancing the pressures in the primary and secondary fuel chambers to reduce fuel surges in the secondary fuel supply system particularly when the secondary fuel inlet valve opens and closes.

Other objects and features of the invention will become apparent as the following description proceeds, especially when taken in conjunction with the accompanying drawings, wherein:

FIG. 1 is a top plan view of a carburetor constructed in accordance with my invention but with the primary and secondary air valves omitted so as to expose the venturi boosters in the primary and secondary air intake passages.

FIG. 2 is a front view of the carburetor with parts shown in section and parts in elevation.

FIG. 3 is an enlarged fragmentary top plan view showing a venturi booster.

FIG. 4 is a sectional view taken on the line 4—4 in FIG. 3.

FIG. 5 is an enlargement of a portion of FIG. 1.

FIG. 6 illustrates a modification.

FIG. 7 illustrates a further modification.

Referring now more particularly to the drawings, the carburetor is shown as being of the down-draught type but can be used in any position and comprises a housing **1** having a primary system **3** and a secondary system **4.** The carburetor is of the four-barrel type although it will be understood that the invention is also applicable to one and two-barrel carburetors.

The carburetor has two primary air intake passages **13P** and two secondary air intake passages **13S.** Only one of the primary intake passages and one of the secondary air intake passages and their associated parts will be described in detail, although it should be understood that the other primary and secondary air intake passages and their associated parts may be the same as those described.

The primary and secondary air intake passages **13P** and **13S** are formed by adjacent vertical bores in the housing **1.** The passages **13P** and **13S** are separated by the housing wall **15.** The air intake passage **13P** is controlled by a suitably actuated throttle valve plate **19** therein secured to a pivotal shaft or pin **19'**. The primary throttle plate **19** is shown at off-idle and may move from off-idle through part throttle to wide open position in which it is disposed substantially vertically in the passage.

The wall of primary air intake passage **13P** is provided intermediate its ends with an annular restriction forming a main venturi **20P** for the air flow. A booster venturi **21P**, more fully described hereinafter, of greater restriction than the main venturi **20P** is disposed in the throat of the main venturi.

A primary air valve **22P** is secured to a pivotal shaft or pin **22'** upstream of the throttle plate **19** and booster venturi **21P** adjacent the top of the primary air intake passage **13P.** The air valve **22P** may move from the closed position illustrated to a fully open substantially vertical position.

The air valve **22P** is subject to the depression (vacuum) in the air intake passage and also to the position of the throttle valve **19.** A lever **23** is secured to the shaft **19'** of the throttle valve **19** and a lever **24** is secured to the shaft **22'** of the air valve **22P.** A rod **25** is pivoted to lever **23** and has a spring-biased lost motion connection with the lever **24.** This lost motion is provided by a pin **26** movable in an arcuate slot **27** in lever **24** which is centered on the axis of pin **22'**. The pin has an abutment **28** which is slidable on rod **25.** A coil spring **29** on rod **25** is compressed between a fixed abutment **30** on the rod and the sliding abutment **28** to impose a yielding bias tending to close the air valve. Nut **31** threaded on the end of rod **25** is to retain abutment **28** and may be threaded either way to change the compression on spring **29.** Obviously this yielding bias is reduced or partially relieved by the counterclockwise opening movement of the throttle valve. The yielding bias permits the air valve to move in opening and closing directions in response to changes in the depression (vacuum) in the air intake passage. The slot **27** allows the air valve **22P** to move in a closing direction by differential pressure independently of the throttle plate **19.**

The primary system also includes a fuel-receiving portion which has a fuel reservoir or chamber **2P.** The fuel chamber **2P** is a closed chamber being defined in part by a cavity in the housing and in part by a flexible diaphragm **5P** which is clamped over an opening in the cavity by a cover plate **9P.** The fuel chamber **2P** is completely unvented and isolated from the outside atmosphere.

Fuel is admitted to the chamber **2P** from a suitable fuel inlet **6P** past a fuel control valve **7P.** The fuel control valve **7P** includes a cylinder *7a* having an elongated, axially movable needle valve *7b* therein projecting through an orifice *7c*. The needle valve *7b* has a head 7*d* adapted to close the orifice and is normally urged to closed position by a calibrated spring AP bearing at one end against the head 7*d* and at the other end against the wall of the cylinder 7*a*. The needle valve 7*b* also has a stem 7*e* projecting from the head 7*d* and engageable with the diaphragm **5P**. The inlet **6P** opens into the interior of the cylinder 7*a* but fuel from the inlet enters the chamber **2P** only when the needle valve 7*b* is opened by the movement of the diaphragm **5P** to the left in FIG. **2.**

The primary system **3** has a main jet **23P** leading to the fuel passages **24P** and **25P**. The passage **25P** leads to the booster venturi **21P** and the passage **24P** leads to the idle ports **27′** and **28′**. Idle ports **27′** and **28′** are open to manifold vacuum in the curb-idle position of the throttle plate **19** to provide a proper fuel mixture. The size of the idle port **28′** is controlled by an idle adjustment screw **29P**.

The diaphragm **5P** is exposed to the pressure within the fuel chamber **2P** on one side and to atmospheric pressure on the other side, and is movable in response to differential pressure. Movement of the diaphragm **5P** to the left in FIG. **2** will move the needle valve **7P** to the left and open orifice 7*c* so that fuel can flow into chamber **2P**.

A mechanical linkage is provided to control the needle valve 7*b* in response to movement of the throttle valve **19.** This linkage is indicated at **46P** and includes a lever **47P** pivoted at its upper end at **60P** to the cover plate **9P**. Intermediate its ends, the lever has an abutment **61P** engageable with, but not secured to, a member **62P** on the outer side of the diaphragm **5P**. At its lower end, the lever **47P** is pivoted to the outer end of a push rod **48P** which extends and slides through an opening in a housing plate **1***b*. The inner end of push rod **48P** engages a cam **50P** secured to and rotatable with throttle plate shaft **19′** so that the cam turns with the throttle plate. A coil spring **64P** compressed between the housing plate **1***b* and a flange **63P** on push rod **48P** holds the inner end of the push rod in contact with the cam **50P**. Rotation of the throttle plate **19** will rotate the cam **50P** and since the inner end of the rod **48P** is in contact with the cam profile, the position of the throttle plate **19** will determine the angular position of the lever **47P**.

Referring to the secondary system **4**, a secondary throttle plate **36S** is secured to a pivotal shaft or pin **36′** in the secondary air intake passage **13S** adjacent the lower end thereof. Throttle plate **36S** is movable from the closed position shown in solid lines to an open substantially vertical position. The primary throttle plate shaft **19′** has a lever **33P** connected to it, and a lever **35S** is connected to the secondary throttle plate **36S**. One end of a rod **34S** is pivoted to the lever **33P** and the other end has a slidable pivotal connection in slot **39S** in the lever **35S** to provide a lost motion connection between the primary and secondary throttle plates.

An air valve **37S** secured to pivotal shaft or pin **37′** is disposed adjacent the top of the secondary air intake passage **13S** for movement from the closed position shown to an open substantially vertical position. The secondary air valve **37S** is normally closed but opens in response to increasing depression (vacuum) in the air intake passage **13S**. Engine manifold vacuum is applied to the air intake passage **13S** when the secondary air valve **36S** opens. Depending upon the particular engine requirements, the responsiveness of air valve **37S** to differential air pressure, and thus its opening rate can be controlled. It is preferable to avoid sudden snap-like opening of the secondary air valve **37S**. For this purpose control means are provided to govern or dampen the opening rate of the air valve **37S**, such control means in this instance being shown as a plurality of pressure relief openings **40S** in the air valve which allow air to pass through at a predetermined calibrated rate. This reduces the initial force exerted on air valve **37S** when secondary throttle plate **36S** is opened, and also provides a controlled initial rate of opening.

There is an annular restriction forming a venturi **20S** in passage **13S** and a booster venturi **21S** in the throat of the venturi **20S**.

Fuel is supplied to the secondary system from a fuel receiving portion which is substantially the same as the fuel receiving portion previously described and accordingly the same reference numerals with the suffix "S" instead of "P" are employed. Thus the fuel chamber **2S** is defined in part by a cavity in the housing and in part by the flexible diaphragm **5S** which is clamped over an opening in the cavity by the cover plate **9S**. The fuel chamber **2S** is a completely closed reservoir unvented to the atmosphere.

The fuel control valve **7S** controls the admission of fuel to the chamber **2S** from the fuel inlet **6S**. The parts of this fuel valve **7S**, namely the portions 7*a*–7*e* are the same as those previously described in connection with the fuel valve **7P** and function in the same manner, and the needle valve 7*b* is acted upon by a similar calibrated spring AS.

The secondary system **4** has a main jet **23S** leading to fuel passages **24S** and **25S**. The passage **25S** leads to the venturi booster **21S** and the passage **24S** leads to the secondary idle port **51.**

The diaphragm **5S** is exposed to the pressure within the fuel chamber **2S** on one side and to atmospheric pressure on the other side, and is movable in response to differential pressure. Movement of the diaphragm **5S** to the right in FIG. **2** will move the needle valve 7*b* of fuel valve **7S** to the right and open orifice 7*c* so that fuel can flow into chamber **2S**.

The mechanical linkage **46S** for controlling the opening of the needle valve of fuel valve **7S** includes the lever **47S** pivoted at its upper end at **60S** to the cover plate **9S**, which lever has an abutment **61S** spaced from the pivot and engageable with but not connected to the member **62S** on the outer side of the diaphragm **5S**.

The lever **47S** has a lost motion connection with the secondary air valve **37S**. A link **40S** is secured to shaft **37′** so as to turn with the air valve **37S**. A rod **41S** is pivoted to the link **40S** and slides through a sleeve **42S** in the lever **47S**. A compression coil spring **43S** encircles the rod between an abutment **44S** on the end of the rod and the sleeve **42S** on the lever. In the closed position of the air valve **37S** shown in FIG. **2,** the lost motion connection will hold the lever **47S** in substantially the position shown. It will be apparent that counterclockwise opening movement of the air valve will, through the resilient lost motion connection, impose a yielding force on the lever **47S** tending to move it counterclockwise and move diaphragm **5S** to the right thereby opening the needle valve 7*b*.

The venturi booster **21P** is shown in FIGS. **3** and **4.** The venturi booster **21S** is of the same construction.

The booster venturi **21P** is in the form of a tubular or ring-shaped body having a central through passage **199** aligned with the air intake passage **13P**. This passage has a restriction at the upper end providing a venturi **203**. A circular channel **200** in the venturi booster encircles the passage **199** at or slightly below the venturi **203** and receives fuel from passage **25P**. Small axially extending venturi openings **201** extend into the channel **200**, and axially extending slightly flaring openings **202**, aligned with openings **201**, extend downward from the channel **200** into the enlarged exit portion **198** of the passage **199**. Fuel moving around the channel **200** is broken up and dispersed by the fast moving air in openings **201** and **202** carried into the exit portion **198** of passage **199**.

Horizontal holes **204** provide communication between the channel **200** and the passage **199** adjacent the restriction or venturi **203**. The restriction terminates in an annular depending lip **205** which partially overlaps the openings **204** to increase the venturi effect and draw fuel from the channel **200** into the air passage **199** by the depression (vacuum) at this point in the air passage.

It will thus be seen that a high degree of atomization or breakup and dispersion of fuel in the circular channel **200** is achieved. The air moving through the axial openings **201** and **202** carries the dispersed fuel with it into the air intake passage **13P**. Simultaneously, air passing the venturi **203**, which is the throat of a pezometer ring, also draws fuel by way of the cross-holes **204** into the passage **199**. Accordingly, fuel is dispersed by both the vertical passages **201** and horizontal passages **204** to atomize the liquid fuel into a homogeneous air-fuel mixture.

A fuel line **98** is shown in FIG. **1** having one end **99** adapted to receive fuel from the tank by a fuel pump. The other end of the line which is a return line to the fuel tank has a restriction **100**. The fuel inlets **6P** and **6S** to the fuel chambers communicate in sequence with the fuel line **99**. This arrangement, including the restriction, reduces the amount of fuel surging in the fuel supply system when the secondary needle valve **7*b*** opens and closes. Also, this arrangement reduces surging on sudden heavy demand when otherwise the secondary system might lag and substantially all of the fuel initially be supplied to the primary system.

A balance tube or passage **101** having a restriction **102** connects the fuel chambers **2P** and **2S**. This arrangement serves to balance pressures in the two chambers and also assists in reducing surges in the fuel supply system when the secondary needle valve **7*b*** opens and closes. It also assists in eliminating a tendency for the secondary system to lag on sudden heavy demand and all of the fuel initially to go to the primary system.

In operation, when the engine is turned over during starting, fuel under pressure from the fuel tank and line **98** enters the fuel inlet passages **6P** and **6S** and fills the passages completely up to fuel valves **7P** and **7S**. The excess fuel passes through restriction **100** and returns to the fuel tank. The primary air valve **22P** is normally in a closed position when the engine is not operating and throttle plate **19** is in the curb-idle position. Cranking the engine induces a depression (vacuum) which is sensed at idle ports **27′**, **28′** and **51**, as well as at the primary venturi booster **21P**. This depression (vacuum) is transmitted through the respective channels and passages **24P**, **25P** and **24S** through the main jets **23P** and **23S** to the chambers **2P** and **2S**. The depression (vacuum) in chambers **2P** and **2S** forces the diaphragms **5P** and **5S** to move or flex inwardly pushing needle valves **7*b*** inwardly against the tension of calibrated springs **AP** and **AS**, opening the orifices **7*c*** and allowing fuel to flow from the inlets into chambers **2P** and **2S**. The fuel in chambers **2P** and **2S** is then transmitted through the main jets **23P** and **23S** to the respective passages **24P**, **24S** and **25P**. Thus fuel initially enters the air stream through idle ports **27′**, **28′**, **51** and booster venturi **21P**. Fuel does not initially flow from booster venturi **21S** because secondary throttle plate **36S** and secondary air valve plate **37S** are closed at this time.

As the engine idles the primary air valve plate **22P** opens slightly, depending on the pre-load and tension of the calibrated primary air valve spring **29** to allow air to enter. The degree of opening of primary air valve **22P** is a function of the rate and tension of the spring **29** which is calibrated for specific air demands. The lighter the pre-load and rate of spring **29**, the greater the amount of air supplied to the engine.

As primary throttle plate **19** opens wider, the primary air valve control rod **25** reduces the tension on spring **29** allowing the primary air valve **22P** to open further, leaning out the air-fuel mixture and still maintaining high air velocities.

The provision of the primary air valve **22P** maintains high air velocities in the primary system at curb-idle, off-idle and low part-throttle (30–40 miles per hour) engine operations so as to achieve a high degree of fuel vaporization and homogeneity of fuel-air mixtures and the entry of the fuel-air mixture into the cylinders of the engine at high air velocities. As a result, a lean homogeneous mixture is achieved reducing overall pollutant emissions. The primary air valve functions to provide these high air velocities until it reaches a substantially vertical position in the air intake passage, which is at a part-throttle position of the throttle plate **19** where secondary throttle plate **36S** begins to open, and is inoperative thereafter.

At the curb-idle position of throttle plate **19**, the engine vacuum at idle ports **27′**, **28′** and **51** is high. This high depression (vacuum) is transmitted by the passages **24P**, **24S** and **25P** to the diaphragms **5P** and **5S** and produces a corresponding inward movement thereof. The amount which the diaphragms move at curb-idle is governed by engine depression only and is not controlled through the mechanical linkages **46P** and **46S**.

As the throttle plate **19** is opened wider from curb-idle, the movement of air through the air passage **13P** draws fuel from the booster venturi **21P**. The depression (vacuum) in the fuel passages is further reduced and in turn the diaphragms **5P** and **5S** move outward by differential pressure and the needle valves **7*b*** begin to close. However, the mechanical linkage **46P** prevents the diaphragm **5P** from moving outward far enough to close the needle valve and maintains a constant linear relationship between the fuel requirements of the engine and the air flow through the carburetor at all positions of the throttle plate **19** other than curb-idle, namely, off-idle, part-throttle and wide-open throttle. For a given position of throttle plate **19** other than curb-idle, a minimum needle valve position of valve **7P** is maintained mechanically by the action of the linkage **46P**. The amount of opening of the needle valve **7*b*** of valve **7P** is governed by the profile of cam **50P** and the lever ratio of lever **47P**.

The rate and amount of opening of the needle valve of valve **7P** is transmitted mechanically from the outer or atmospheric side of the diaphragm **5P**. This mechanical linkage provides the minimum fuel delivery necessary to operate the engine at the lowest permissible hydrocarbon levels. If the velocity of air passing the booster venturi **21P** and the depression (vacuum) at idle ports **27'** and **28'** should increase to an amount greater than normally encountered at a specific throttle opening, the diaphragm **5P** is permitted to flex inwardly away from the lever **47P** by differential pressure allowing a richer mixture in order to maintain a combustible fuel and air mixture to the engine maintaining a constant power output in relation to air consumption demand. However, the differential pressure acting on the diaphragm cannot lean out or reduce the fuel delivery below that which cam **50P** is designed to deliver.

During initial opening of throttle plate **19**, secondary throttle plate **36S** remains closed due to the lost motion built into the linkage **33S-35S**. At an intermediate position of the throttle plate **19P**, called the "pick-up point," the linkage causes secondary throttle plate **36S** to begin to open. By varying the construction of the linkage, the rate of opening of plate **36S** relative to plate **19** can be changed to provide different fuel-air mixtures at different loads and engine speeds to suit performance requirements.

As secondary throttle plate **36S** opens, secondary air valve **37S** is subjected to increased downward air pressure tending to open it from its generally closed position. As this occurs, additional air flow is generated through secondary air passage **13S**. As before stated, control means are provided to govern or dampen the opening rate of the secondary air valve **37S**, here shown as comprising the relief openings **40S**. This reduces the initial force on the secondary air valve **37S** when the secondary throttle plate **36S** is open and also provides a controlled initial rate of opening.

The opening of the secondary throttle plate **36S** results in an increase in manifold depression (vacuum) transmitted through the secondary venturi booster **21S** and passage **25S** due to the closed position of the secondary air valve **37S**. This higher depression is transmitted through the main metering jet **23S** to the secondary diaphragm **5S**. The diaphragm **5S** responding to this higher depression (vacuum) moves the secondary needle valve **7*b*** inward to allow additional fuel to enter chamber **2S** and then via the main jet **23S** and the booster venturi **21S** to enter the engine. When the depression (vacuum) below the secondary air valve **37S** reaches a sufficient magnitude, the secondary air valve begins to open allowing additional air to enter the secondary air intake **13S**. The rate of opening of the secondary air valve **37S** is a function of the rate and tension of the calibrated spring **43S** which opposes such opening movement. The opening of the secondary air valve **37S** in turn moves the lever **47S** counterclockwise by a yielding pressure applied through spring **43S**. Such movement of the lever **47S** shifts the diaphragm **5S** further inwardly to cause needle valve **7*b*** to allow greater amounts of fuel to enter the chamber **2S** and ultimately to flow into the secondary air intake passage **21S**. As secondary air valve **37S** continues to open in response to differential pressure, the lever **47S** is turned further in a counterclockwise direction by the yielding force of spring **43S** to allow even greater amounts of fuel to enter the secondary system.

FIG. **6** shows a modification incorporating a temperature compensation device. The pin **19'** to which the throttle valve plate **19** is secured acts upon the lower end of the rod **25** through a cam **300** and spring strip in the form of a temperature sensitive bimetal strip **302.** One end of the bimetal strip **302** is secured to the carburetor housing **1** by a fastener **304** and the other end of the bimetal strip is pivotally connected to the lower end of the rod **25** where indicated at **306.** The cam **300** is secured to pin **19'** beneath an intermediate portion of the bimetal strip to permit its end **306** to descend when the pin **19'** turns counterclockwise to open the throttle valve plate **19** thereby causing the rod **25** to descend and reduce the closing bias on the primary air valve **22P**. Conversely, clockwise turning of pin **19'** back to the illustrated position to close throttle valve plate **19** will raise the end **306** of bimetal strip **302** and also the rod **25**, increasing the closing bias on the primary air valve **22P**. A decrease in temperature tends to straighten the bimetal strip, having the effect of raising its end **306** attached to the rod **25,** whereas an increase tends to warp it further than that illustrated to lower its end attached to the rod. Raising the end of rod **25** due to a temperature drop increases the tension in spring **29,** whereas lowering rod **25** due to a temperature rise decreases the tension in spring **29.** Thus the bias of the lost-motion connection is increased by a drop in temperature and is decreased by a rise in temperature.

FIG. **7** illustrates a modification of the FIG. **6** construction in which the temperature compensation device **311** is incorporated in the rod **25.** In the FIG. **7** modification, the spring strip **302** (not shown) is not a bimetal member having temperature sensitive characteristics as in FIG. **6,** but is merely an ordinary spring strip element which may be otherwise identical in appearance to the element shown in FIG. **6.** The temperature compensation device **311** comprises a capsule including cylinder **310** having the upper end secured to the upper end portion **25A** of the rod **25.** The lower end portion **25B** of the rod **25** is connected at the bottom to spring strip **302** as in FIG. **6,** and extends upwardly through the bottom end wall of the cylinder and has a piston **312** on its upper end slidable within the cylinder. A body of thermally expansible material **316** is contained within the lower end portion of the cylinder beneath the piston. The bottom wall of the cylinder seals around rod portion **25B** to prevent escape of the thermally expansible material **316.** A coil spring **314** is compressed between the piston **312** and the upper end of the cylinder to hold the piston pressed against the body of thermally expansible material **316.** An air vent **313** in the upper end of the cylinder prevents air from being trapped therein. The thermally expansible material **316** expands in response to an increase in temperature thereby decreasing the effective length of the rod **25** and correspondingly decreasing the tension in spring **29.** Such material contracts in response to a decrease in temperature thereby increasing the effective length of rod **25** and correspondingly increasing the tension in spring **29.** Thus the bias in the lost-motion connection is increased by a drop in temperature and is decreased by a rise in temperature.

I claim:

1. In a carburetor, an air intake passage, a throttle valve controlling said air intake passage, a fuel passage leading into said air intake passage, an air valve in said air intake passage upstream from said throttle valve, and yieldable means urging said air valve to closed position, said air valve being adapted to open against the action of said yieldable means in response to vacuum in said air intake passage, said yieldable means including a rod connected to said throttle valve, a pin having a lost-motion connection with said air valve, spring means between said rod and pin, and means for adjusting the tension of said spring means.

2. In a carburetor, primary and secondary systems respectively having primary and secondary air intake passages, throttle valve means controlling said primary and secondary air intake passages, primary and secondary closed fuel chambers, primary and secondary fuel passages respectively leading from said primary and secondary fuel chambers to said primary and secondary air intake passages, primary and secondary fuel inlet passages to said respective primary and secondary chambers, fuel valves controlling the flow of fuel respectively from said primary and secondary fuel inlet passages to said primary and secondary fuel chambers, a fuel line leading from a source of fuel under pressure and communicating with said fuel inlet passages in sequence and then leading back to the source and a restriction in the portion of said fuel line leading back to the source.

3. In a carburetor, primary and secondary systems respectively having primary and secondary air intake passages, throttle valve means controlling said primary and secondary air intake passages, primary and secondary closed fuel chambers, primary and secondary fuel passages respectively leading from said primary and secondary fuel chambers to said primary and secondary air intake passages, primary and secondary fuel inlet passages to said respective primary and secondary chambers, fuel valves controlling the flow of fuel respectively from said primary and secondary fuel inlet passages to said primary and secondary fuel chambers, and pressure balance tube passage means connecting said primary and secondary chambers balancing pressures therein and placing the same in communication with one another.

4. The structure defined in claim **3**, wherein said balance tube passage means has a restriction therein.

5. In a carburetor, an air intake passage, a throttle valve controlling said air intake passage, a fuel passage leading into said air intake passage, an air valve in said air intake passage upstream from said throttle valve, and yieldable means urging said air valve to closed position, said air valve being adapted to open against the action of said yieldable means in response to vacuum in said air intake passage, said yieldable means including a rod connected to said throttle valve, a pin having a lost-motion connection with said air valve, and spring means between said rod and pin.

6. In a carburetor, a primary air intake passage, a primary throttle valve controlling said air intake passage, a primary fuel passage leading into said air intake passage, a primary air valve in said air intake passage upstream from said throttle valve adapted to open in response to vacuum in said air intake passage, means providing a connection between said throttle valve and said air valve to open said air valve in response to opening movement of said throttle valve, said connection means including spring means imposing a yielding closing bias on said air valve with a force dependent upon the position of said throttle valve.

7. The structure defined in claim **6**, wherein said connection means includes a first member connected to one of said valves, a second member connected to the other of said valves, and spring means between said first and second members.

8. In a carburetor, a primary air intake passage, a primary throttle valve controlling said air intake passage, a primary fuel passage leading into said air intake passage, a primary air valve in said air intake passage upstream from said throttle valve adapted to open in response to vacuum in said air intake passage, means providing a connection between said throttle valve and said air valve to open said air valve in response to opening movement of said throttle valve, said connection means including spring means imposing a yielding closing bias on said air valve when said throttle valve is in curb-idle position, said air valve being substantially fully open when said throttle valve is at a part-throttle position.

9. The structure defined in claim **8**, including a secondary air intake passage, a normally closed secondary throttle valve in said secondary air intake passage, a secondary air valve in said secondary air intake passage upstream from said secondary throttle valve adapted to open in response to vacuum in said secondary air intake passage, a secondary fuel passage leading to said secondary air intake passage between said secondary throttle valve and said secondary air valve, and a lost-motion connection between said primary throttle valve and said secondary throttle valve to open said secondary throttle valve in response to opening movement of said primary throttle valve past said part-throttle position in which said primary air valve is substantially fully open.

10. The structure defined in claim **9**, including a secondary fuel valve controlling the flow of fuel to said secondary fuel passage, means subject to the vacuum in said secondary air intake passage for moving said fuel valve in an opening direction in response to an increase in vacuum and in a closing direction in response to a decrease in vacuum, and means for maintaining said secondary fuel valve open a predetermined minimum amount dependent upon the position of said secondary air valve regardless of the vacuum in said secondary intake passage.

11. In a carburetor, a primary air intake passage, a primary throttle valve controlling said primary air intake passage, a fuel passage leading to said primary air intake passage, a secondary air intake passage, a normally closed secondary throttle valve in said secondary air intake passage, a secondary air valve in said secondary air intake passage upstream from said secondary throttle valve, a secondary fuel passage leading to said secondary air intake passage between said secondary throttle valve and said secondary air valve, a fuel valve controlling the flow of fuel to said secondary fuel passage, means subject to the vacuum in said secondary air intake passage for moving said fuel valve in an opening direction in response to an increase in vacuum and in a closing direction in response to a decrease in vacuum, and means for maintaining said secondary fuel valve open at least a predetermined amount dependent upon the position of said secondary air valve regardless of and independently of the vacuum in said secondary air intake passage.

12. In a carburetor, a primary air intake passage, a primary throttle valve controlling said primary air intake passage, a fuel passage leading to said primary air intake passage, a secondary air intake passage, a normally closed secondary throttle valve in said secondary air intake passage, a secondary air valve in said secondary air intake passage upstream from said secondary throttle valve, a secondary fuel passage leading to said secondary air intake passage between said secondary throttle valve and said secondary air valve, a fuel valve controlling the flow of fuel to said secondary fuel passage, means subject to the vacuum in said secondary air intake passage for moving said fuel valve in an opening direction in response to an increase in vacuum and in a closing direction in response to a decrease in vacuum, and means for maintaining said secondary fuel valve open a predetermined amount dependent upon the position of said secondary air valve regardless of the vacuum in said secondary air intake passage, said last-mentioned means including a member movable in one direction to open said fuel valve, and a yieldable connection between said secondary air valve and said member.

13. In a carburetor, a primary air intake passage, a throttle valve controlling said air intake passage, a fuel passage leading into said air intake passage, an air valve in said air intake passage upstream from said throttle valve adapted to open in response to vacuum in said air intake passage, yieldable means resisting opening movement of said air valve with a force dependent upon the position of said throttle valve, and means for increasing the force of said yieldable means in response to a decrease in temperature and for decreasing the force of said yieldable means in response to an increase in temperature.

14. In a carburetor, a primary air intake passage, a throttle valve controlling said air intake passage, a fuel passage leading into said air intake passage, an air valve in said air intake passage upstream from said throttle valve adapted to open in response to vacuum in said air intake passage, yieldable means resisting opening movement of said air valve with a force dependent upon the position of said throttle valve, said yieldable means including a rod, a pin having a lost-motion connection with said air valve, spring means between said rod and pin adapted to apply a closing bias on said air valve through said pin, a connection between said rod and throttle valve including a temperature sensitive element, said element upon a drop in temperature moving said rod to increase the tension of said spring means and hence the closing bias on said air valve and upon a rise in temperature moving said rod to decrease the tension of said spring means and hence the closing bias on said air valve.

15. The structure defined in claim 14, wherein said temperature sensitive element is a bimetal strip.

16. In a carburetor, a primary air intake passage, a throttle valve controlling said air intake passage, a fuel passage leading into said air intake passage, an air valve in said air intake passage upstream from said throttle valve adapted to open in response to vacuum in said air intake passage, yieldable means resisting opening movement of said air valve with a force dependent upon the position of said throttle valve, said yieldable means including a rod, a pin having a lost-motion connection with said air valve, spring means between said rod and pin adapted to apply a closing bias on said air valve through said pin, means providing a connection between said rod and throttle valve, and a temperature sensitive device incorporated in said rod operable to alter the effective length of said rod in response to temperature changes such that the tension of said spring means and hence the closing bias thereof is increased upon a drop in temperature and is decreased upon a rise in temperature.

17. The structure defined in claim 16, wherein said temperature sensitive device is a capsule containing a thermally expansible material.

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