Feb. 5, 1952 A. W. ORR, JR 2,584,911

PRESSURE CARBURETOR

Filed March 17, 1947 2 SHEETS--SHEET 1

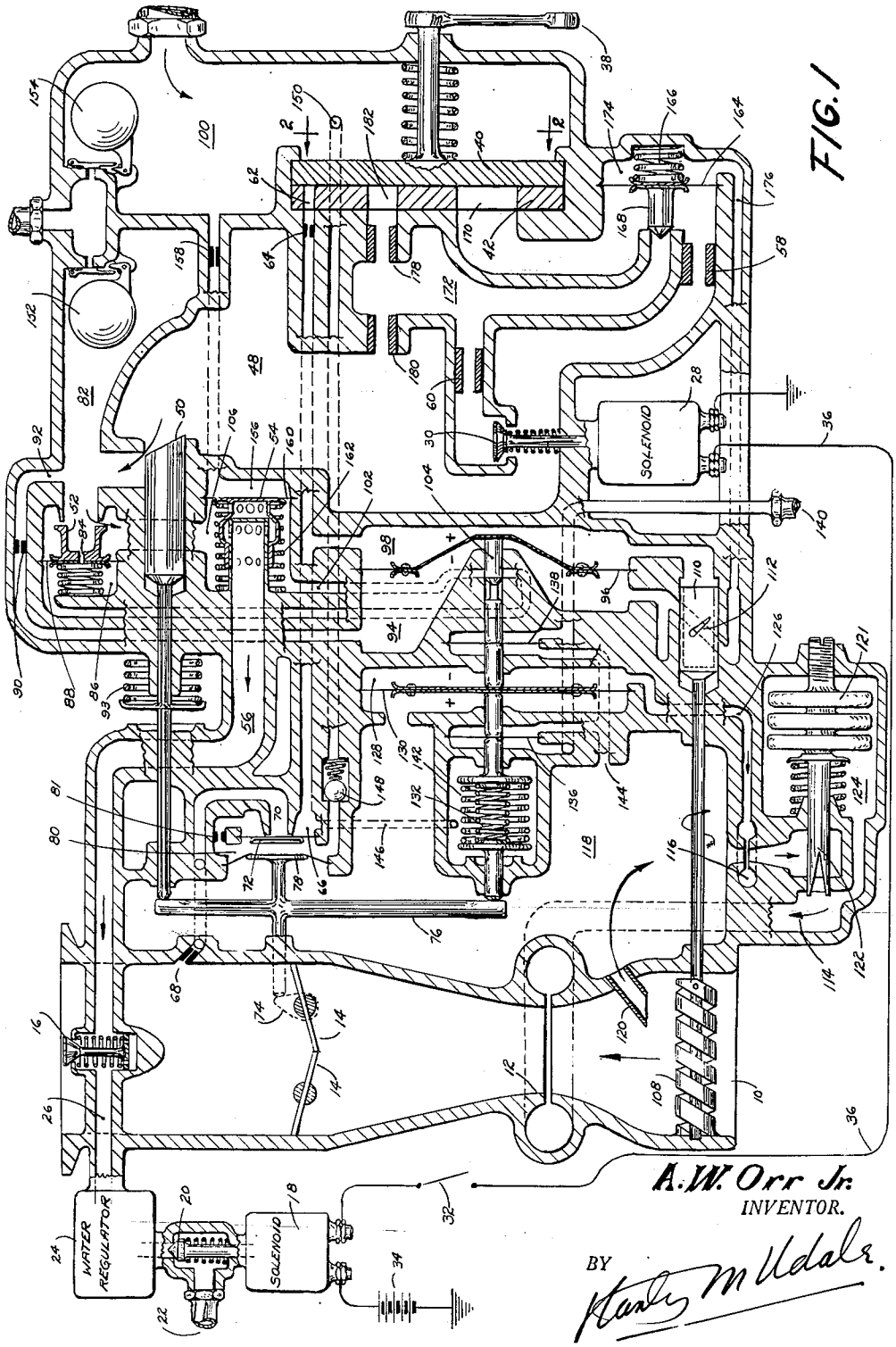


FIG. 1

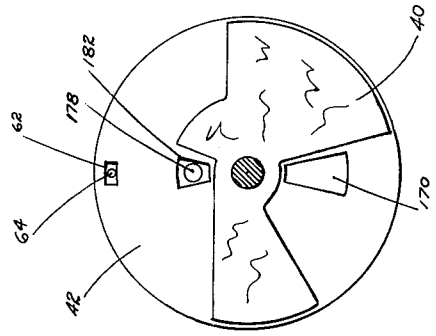
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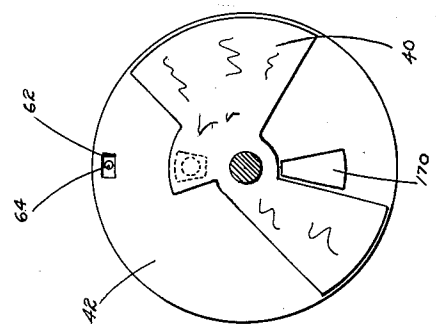
PRESSURE CARBURETOR

Filed March 17, 1947 2 SHEETS--SHEET 2



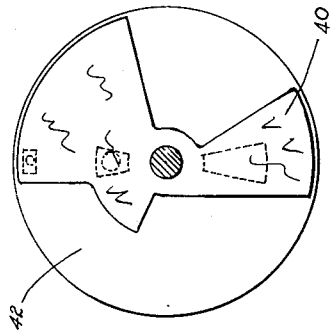
RICH

FIG. 4



NORMAL

FIG. 3



CUTOFF

FIG. 2

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PRESSURE CARBURETOR

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7 Claims. (Cl. 261—18)

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The object of this invention is to make an airplane carburetor which will compensate for altitude and temperature and provide more satisfactory acceleration.

Fig. 1 shows diagrammatically the preferred form of my invention.

Fig. 2 shows the fuel control valve in the idle cut-off position taken on the plane II—II of Fig. 1.

Fig. 3 shows the fuel control valve in the normal (lean) position.

Fig. 4 shows the fuel control valve in the rich position.

In Fig. 1, 10 is the air entrance, 12 is the venturi, 14 are the throttle valves which are linked together by links, not shown, so as to open together. 16 is the fuel nozzle discharging on the engine side of the throttle valves 14. 18 is the electric solenoid which controls the water regulating valve 20. Water regulating valve 20 admits water from the pipe 22 to the water regulator 24 which discharges water through the passage 26 to the fuel outlet valve 16. 28 is a similar solenoid adapted to close the fuel valve 30 simultaneously with the opening of the water valve 20. Manually operated switch 32, a battery 34, and an electric conduit 36 completes this detail.

The fuel mixture ratio control lever 38 controls the disc 40. The fuel passes this disc 40 and passes through the ports 170—182—62 in the plate 42. The fuel flowing through the port 62 flows through the restriction 64 to the passage 66, through the passage 70 to the outlet orifice 68 on the engine side of the throttles 14. This is the acceleration fuel. The fuel flowing through the port 182 flows through the restriction 178 and the fuel passing the orifice 178 divides into two paths in the passage 172. Some of the fuel flows through the restriction 180 and some of the fuel flows through the restriction 60. Additional fuel enters the passage 172 past the valve 168. This fuel flows from the fuel entrance 100 through the port 170. Fuel flowing through port 170 also flows through restriction 58. Fuel flowing through restriction 60 flows past the solenoid valve 30, already mentioned. All of these streams of fuel flow into the chamber 48.

In the position shown in Fig. 4, that is in the rich position, fuel also enters through the port 182 and restriction 178.

When the valve 40 is in the rich position, shown in Fig. 4, the port 62 in the plate 42 is uncovered by the disc 40. The port 62 communicates through the restriction 64 to the passage 66. This passage 66 provides accelerating fuel to the accelerating jet 68. A passage 70, controlled by the diaphragm valve 72, is normally inactive. When the right hand throttle valve 14 is opened the cam 74 permits the element 76 to move to the left under the influence of the spring 93 and the springs 132. The diaphragm 78 then moves to the left and as it moves to the left the volume of the chamber 80 is enlarged so that the diaphragm valve 72 moves to the left and fuel flows from port 62 through the restriction 64, past the diaphragm valve 72, along the pipe 70 to the jet 68. The time the diaphragm valve 72 remains off its seat is determined by the small bleed passage 81. When the throttle valves 14 are closed the fuel trapped in the chamber 80 escapes past the spring loaded check valve 148, along the passage 150 back to the fuel entrance chamber 100.

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When the throttle valves 14 are open not only is the accelerating fuel admitted through the accelerating orifice 68 but the low speed fuel valve 50 is opened and the spring load 132 is reduced. The fuel flows past the low speed fuel valve 50 into the chamber 82 which contains the vapor separating elements 152. Fuel flows out of the chamber 82 past the valve 52. In the center of the automatic valve 52 there is a restriction 84. The pressure in the chamber 82, to the right of the automatic valve 52, is thus transmitted through the valve 52 to the chamber 86, to the left of the diaphragm 88 which supports the valve 52 and is pushed to the right by a spring contained in the chamber 86.

A restriction 90, in the passage 92, also transmits the pressure from the chamber 82 to the chamber 94, to the left of the fuel responsive diaphragm 96. The chamber 98, to the right of the fuel responsive diaphragm 96, is maintained at the pressure of the fuel in the fuel entrance 100, through the restriction 64 and the passage 66, through the port 62 in the plate 42. Servomotor valve 104 controls the flow through the passage 92. The fuel flowing from passage 102 to the chamber 106 is in free communication with the downstream side of the valve 52. The servomotor valve 104 thus controls the opening and closing of the automatic valve 52.

The chamber 156 is connected through the restriction 158 with the fuel entrance chamber 100. Chamber 156 is located to the right of the diaphragm 160, which diaphragm carries the balance valve 54. The spring 162 supports the balance valve 54 and opposes the pressure transmitted through the restriction 158.

The thermostat 108 rotates the valve 110 and

thereby varies the pressure difference between the chamber 94 and the chamber 98 so that the fuel/air ratio is maintained constant for temperature variations of the air entering the carburetor. The slot 112, in the valve 110, is shaped so that this result is accomplished.

Air enters the carburetor, flows up the air entrance 10, through the impact tube 120, down the air chamber 118, into the small venturi 116, past the small regulating valve 122, up the passage 114 into the throat of the venturi 12. Flow through this little venturi is varied with the altitude by the barometric element 121. Barometric element 121 controls the position of the regulating valve 122 and is itself controlled by the pressure in the chamber 124. The pressure in chamber 124 is the pressure in the throat of the venturi 12. The depression in the throat of the small ventur is conveyed through the passage 126 to the chamber 128, to the right of the air responsive diaphragm 130. The pressure acting on the left face of the air responsive diaphragm 130 is the pressure in the air entrance 10, through the impact tube 120 and the air chamber 118.

The double springs 132 are interposed between the element 76 and the air responsive diaphragm 130. The little diaphragms 136—138 are provided to remove any leakage and a pipe 140 acts as a drain outlet for the chambers to the left of the small diaphragm 136 and to the right of the small diaphragm 138. The chambers to the right of the diaphragm 136 and to the left of the diaphragm 138 are connected through a passage 144 to the air chamber 118. Chamber 142, surrounding the double spring 132, is connected through the passage 146 to the passage 66.

The vapor outlet mechanism 152—154 is used for an obvious reason. 154 is located in the the chamber 100.

The diaphragm 164 is spring loaded with spring 166 and carries a valve 168. This valve 168 controls part of the flow through the port 170 and into the bypass 172. Chamber 174, to the right of diaphragm 164, is connected to the chamber 94 through the passage 176.

Operation

In the normal operation, at sea level, with warm air flowing through the air entrance 10 and with the temperature slot 112, in the temperature control valve 110 almost closed, the following sequence of events happens when the throttle valves 14 are opened.

The opening of the valves 14 causes the cam 74 to rotate anticlockwise. Low speed valve 50 opens and the spring load, imposed on the air responsive diaphragm by the spring 132, is reduced as the cam follower 76 follows the cam 74 to the left. Although the low speed valve 50 opens and admits more fuel the reduction of pressure on the spring 132 causes the fuel/air ratio to fall until the throttle valves are approximately ⅓ open. The fuel/air ratio is controlled thereafter by the well known means now in almost universal use on airplanes, namely, the air diaphragm 130 responding to the depression in the small venturi 116 and the fuel diaphragm 96 which responds to the pressure difference between the fuel entrance 100 and the pressure transmitted through the passage 92 from the chamber 82. Chamber 82 is now at the same pressure as the pressure in chamber 48 because the valve 50 is moved over to the left in the clear.

The variation in air flow through the venturi 12 and the variation in fuel flow through the restrictions balance each other. Therefore, whether the fuel control is set at rich or normal the fuel/air ratio is maintained substantially constant. (Figs. 3 or 4.)

When the fuel flow reaches a certain critical value the fuel entering the port 170 raises the valve 168 because the pressure in the chamber 174 falls to a critical value. The chamber 174 is connected through the passage 176 to the chamber 94, which is the low pressure side of the fuel responsive diaphragm 96. This fuel is admitted past the restriction 60 and past the solenoid operated valve 30 and also past the restriction 180. This provides the necessary rich mixture for wide open throttle.

Temperature correction

It will be noted that the lower the temperature the more the slot 112 opens and the smaller the pressure difference acting on the diaphragm 164, therefore the later the valve 168 opens. Therefore it takes a greater air flow to open the valve 168. The valve 168 is closed by the spring 166. The reason for this is that the additional fuel is more desirable when the engine is hot, running under hot conditions, than when flying in cold air.

When flying with the throttle valves less than ⅓ open, at a low temperature, slot 112 opens lowering the pressure differential between the chambers 94 and 98. This lowered pressure difference, which when the throttle valves are more than ⅓ open is merely sufficient to maintain the constant fuel/air ratio by weight, has a contrary effect when the throttle valves are less than ⅓ open because then the spring pressure 132 is constant regardless of temperature, depending only on throttle position.

Therefore, as the forces necessary to balance the fuel diaphragm against the air diaphragm diminish, the constant spring pressure has a tendency to make the fuel/air ratio richer at small throttle openings the slot 112 in the valve 110 opens, and thereby reduces the pressure difference between the chambers 94 and 98 when the entering air is cold.

When the port 182 in the plate 42 is closed, for normal operation (Fig. 3), then the flow through jets 178—180—60 are also closed. The flow through jet 58 continues but the valve 168 opens at the same air flow as air flow pressure differential balances the fuel flow pressure differential. When the valve 168 opens the fact that port 182 is closed, gradually becomes of less and less importance until the flow through jet 180 is as great as the flow through port 182 when port 182 is wide open.

It thus follows that the enrichening effect of valve 168 starts at the same air flow whether the lever 38 is set for normal or rich running but ultimately the fuel/air ratio at maximum air flow is the same.

Again when valve 30 is closed the fuel/air ratio at maximum air flow is the same whether the lever 38 is set for rich or for normal operation.

When the temperature is high (140° F.) in the air entrance 10 then the port 112 is closed and the fuel pressure drop across the diaphragm 96 is the maximum for the given conditions of air flow. If we call the velocity of air 10 and the density 1, at which valve 168 opens, we have velocity squared times density which equals 100. If the air is very cold and the density is 1.4 then velocity is .707 for the same weight of air, the velocity squared times density now equals .70.

Hence the valve 168 will not lift until the air flow increases and horsepower increases greatly.

When hot (plus 140° F.) the enrichment occurs at relatively low horsepower. On the other hand at —70° F., which is not unusual at high altitudes, the enrichment does not occur until the power is much greater. This saves fuel and the engine actually performs better.

Altitude correction

At altitude the bellow 121 expand, regulating valve 122 moves to the left, the venturi suction in the small venturi 116 is thereby diminished so that the pressure differences acting on the air responsive diaphragm 130 are reduced. This action calls for less fuel to balance the lower air pressure so that the fuel/air ratio is maintained constant at altitude.

The substitution of water for the enrichening fuel added through the restriction 60 is no part of this invention and is merely shown to illustrate the usual features of a modern carburetor.

Obviously the fuel admitted past the valve 168 has the same function as the water admitted past the valve 20, that is, to prevent the engine from overheating at maximum power.

What I claim is:

1. A pressure carburetor having a fuel supply under pressure, a fuel passage connected thereto and leading to said carburetor, a fuel restriction in said passage, an air entrance to said carburetor, a venturi in said air entrance, an air diaphragm, a pressure chamber on one side of said diaphragm connected to said air entrance, a suction chamber on the other side connected to the throat of said venturi, a passage forming the connection, a valve located in said passage, a bellows chamber freely connected to the throat of said venturi, a completely evacuated bellows located in said bellows chamber and connected to said valve so as to reduce the suction effect of said venturi at high air flows and at high altitudes, a temperature responsive element in said air entrance, a fuel diaphragm, a pressure chamber on one side of said diaphragm connected to the pressure upstream from said fuel restriction, a depression chamber on the other side of said diaphragm connected to the downstream side of said destriction, an additional passage from the upstream to the downstream side of said fuel restriction, an automatic valve in said additional passage, opening means therefor responsive to the pressure differences across said fuel diaphragm, a bypass from the pressure to the depression side of said fuel diaphragm, a valve in said bypass connected to the said temperature responsive element, a fuel control valve in said fuel passage, control means therefor connected to both fuel and air diaphragms so as to maintain at moderate airflows a substantially constant fuel/air ratio independent of temperature changes and whereby the air flow at which the automatic valve opens is greater at low temperatures than at high temperatures.

2. A pressure carburetor having a fuel supply under pressure, a fuel passage connected thereto and leading to said carburetor, a constantly open fuel restriction therein, a temporarily open fuel restriction therein in parallel with the first mentioned restriction, manual means for opening and closing said temporary restriction, an air entrance, temperature responsive means and a venturi in said air entrance, an air diaphragm, a pressure chamber on one side of said diaphragm connected to the air entrance, a suction chamber on the other side of said diaphragm connected to the throat of said venturi, a fuel diaphragm, a pressure chamber on one side of said fuel diaphragm connected to the pressure upstream of said fuel restrictions, a depression chamber on the other side of said fuel diaphragm connected to the downstream side of said fuel restriction, a bypass from the pressure chamber to the depression chamber of said fuel diaphragm, a valve in said bypass connected to the temperature responsive means, a fuel control valve, control means therefor connected to both diaphragms so as to maintain approximately a constant fuel/air ratio at moderate air flows, an additional fuel passage in parallel with said fuel restrictions, an automatic valve in said additional fuel passage, opening means therefor responsive to the pressure difference across said fuel diaphragm, a fixed restriction downstream from said automatic valve, said temporarily opened fuel restriction being located so as to flow into said additional passage between the automatic valve and the fixed restriction whereby as the automatic valve is gradually opened the temporarily opened fuel restriction gradually ceases to contribute additional fuel.

3. A device as set forth in claim 2 in which there is a water supply passage adapted to discharge water into said carburetor downstream from said venturi, a water control valve for said water passage and in which the additional passage into which the temporarily open fuel restriction discharges has a second fixed restriction in parallel with the first fuel restriction, a control valve for preventing flow through said second fixed restriction, manually operated means for simultaneously closing said valve and opening the water supply valve in said water passage.

4. A carburetor having a supply of fuel under pressure, a fuel passage connected thereto, a restriction in said passage, an air entrance, a primary venturi in said air entrance, a small venturi delivering air to the throat of said primary venturi, a regulating valve controlling the flow of air from said small venturi, a completely evacuated bellows responsive to the pressure in the throat of said primary venturi, said regulating valve being controlled by said evacuated bellows, an air diaphragm responsive to the pressure of the air entrance on one side and on the other to the suction in the throat of said small venturi, a fuel diaphragm responsive to the drop in pressure of the entering fuel at said fuel restriction, a fuel control valve adapted to control the fuel flow through said fuel passage, control means for said valve connected to said air and fuel diaphragms so that the difference in pressure acting on said air diaphragm opposes and balances the difference in pressure acting on said fuel diaphragm and moves the fuel control valve so as to balance air flow against fuel flow and to thereby maintain a substantially constant fuel/air ratio by weight at varying air pressures, a throttle valve in the air entrance downstream from said primary venturi, yieldable means interposed between said throttle valve and said diaphragm control means for said fuel control valve whereby as the throttle valve is closed the pressure difference imposed on said air diaphragm by air flow through said venturi is supplemented by pressure exerted by said yieldable means to oppose the fuel pressures acting on said fuel diaphragm during approximately the first ⅓ travel of the throttle valve from its closed throttle position, a bypass

from the high to the low pressure side of said fuel diaphragm, a valve in said bypass, temperature responsive means located in said air entrance connected to said valve so as to open said valve at low temperature, a variable low speed fuel restriction in series with the first mentioned fuel restriction and connected to said throttle valve so as to be closed thereby as the throttle valve is closed, the yieldable pressure decreasing and the variable fuel restriction opening as the throttle valve is moved from closed position to a point which is approximately ⅓ open when the variable fuel restriction ceases to restrict the fuel flow.

5. In a pressure carburetor, a source of fuel under pressure, a fuel supply passage, an air passage, an air entrance, a venturi in said air entrance, an air outlet having a throttle valve therein, two air chambers, one connected to the air entrance, the other to the throat of said venturi, a movable wall interposed between said two air chambers, a fixed restriction in the fuel passage, a variable fuel restriction in series with the fixed restriction, a valve in the variable restriction and connected to the air throttle valve so that it progressively closes the restriction as the air throttle valve is moved from ⅓ open to its closed position, two fuel chambers, one connected to the fuel supply passage upstream of said two restrictions, the other downstream of said two restrictions and a second moving wall interposed between the two chambers, a servomotor valve operatively connected to both of said moving walls so that the effect of an increase in air flow opposes the effect of an increase in fuel flow, a pressure responsive valve in series with and located downstream of said two fuel restrictions and hydraulically controlled by said servomotor valve so that the pressure responsive valve admits more fuel in response to an increase in air flow and less fuel flow in response to a decrease in air flow, yieldable means connected to and varied by the position of said air throttle valve and adapted to progressively supplement the force acting on the air flow responsive moving wall whenever the air throttle valve is closed more than ⅔ shut, the force acting on the fuel flow responsive moving wall being increased by the amount of the pressure drop at said manually variable fuel restriction so as to increase the force opposing said yieldable means which thus supplements the force derived from the flow of air through said venturi acting on the air flow responsive moving wall, temperature responsive means located so as to respond to the temperature of the air in the air entrance, a bypass valve controlled by the temperature responsive means communicating with the two fuel chambers and adapted to reduce the total pressure drop between said two fuel chambers at low air temperatures whereby whenever the air throttle valve is less than ⅓ open, the lower the air temperature, the richer is the mixture at the lower air flow associated with the air throttle valve as it is moved to its closed position from ⅓ open position.

6. A carburetor having a supply of fuel under pressure, a fuel passage connected thereto, a restriction in said passage, an air entrance, a primary venturi in said air entrance, a small venturi delivering air to the throat of said primary venturi, a regulating valve controlling the flow of air from said small venturi, a completely evacuated bellows, a chamber surrounding said bellows in free communication with and at the pressure in the throat of said primary venturi, said regulating valve being controlled by said evacuated

bellows, an air diaphragm responsive to the pressure of the air entrance on one side and on the other to the suction in the throat of said small venturi, a fuel diaphragm responsive to the drop in pressure of the entering fuel at said fuel restriction, a fuel control valve adapted to control the fuel flow through said fuel passage, control means for said valve connected to said air and fuel diaphragms so that the difference in pressure acting on said air diaphragm opposes and balances the difference in pressure acting on said fuel diaphragm and moves the fuel control valve so as to balance air flow against fuel flow and to thereby maintain a substantially constant fuel/air ratio by weight at varying air pressures, a bypass from the high to the low pressure side of said fuel diaphragm, a valve in said bypass, a temperature responsive element located in the air entrance and connected to said valve so as to open said valve at low temperatures and to close said valve at high temperatures so as to maintain a substantially constant fuel/air ratio by weight at varying air temperatures, a low speed valve in the fuel passage in series with said fuel restriction, a throttle valve in the air entrance downstream from said primary venturi, manual control means for said throttle valve, yieldable means interposed between said throttle control and the diaphragm control means for said fuel control valve, a passage connecting the low pressure side of said fuel diaphragm to the downstream side of said low speed fuel valve, mechanism connected to the throttle valve, adapted to close the low speed fuel valve when the throttle valve is moved towards its closed position so that the pressure difference acting on the air diaphragm added to said yieldable means jointly balance the increased fuel pressure drop responsive to the closure of the low speed fuel valve.

7. A carburetor having a supply of fuel under pressure, a fuel passage connected thereto, a restriction in said passage, an air entrance, a primary venturi in said air entrance, a small venturi delivering air to the throat of said primary venturi, a regulating valve controlling the flow of air from said small venturi, a completely evacuated bellows, a chamber surrounding said bellows in free communication with and at the pressure in the throat of said primary venturi, said regulating valve being controlled by said evacuated bellows, an air diaphragm responsive to the pressure of the air entrance on one side and on the other to the suction in the throat of said small venturi, a fuel diaphragm responsive to the drop in pressure of the entering fuel at said fuel restriction, a fuel control valve adapted to control the fuel flow through said fuel passage, control means for said valve connected to said air and fuel diaphragms so that the difference in pressure acting on said air diaphragm opposes and balances the difference in pressure acting on said fuel diaphragm and moves the fuel control valve so as to balance air flow against fuel flow and to thereby maintain a substantially constant fuel/air ratio by weight at varying air pressures, a bypass from the high to the low pressure side of said fuel diaphragm, a valve in said bypass, a temperature responsive element located in the air entrance and connected to said valve so as to open said valve at low temperatures and to close said valve at high temperatures so as to maintain a substantially constant fuel/air ratio by weight at varying air temperatures, a second fuel passage in parallel with the first mentioned fuel passage, a second fuel diaphragm responsive to

the pressure difference acting on the first mentioned fuel flow responsive diaphragm, a second fuel control valve located in said second fuel passage and controlled by said second fuel diaphragm whereby at abnormally low temperatures the opening of said second valve is delayed until a relatively high air flow is reached.

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