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FUEL FEEDING DEVICE FOR ENGINES

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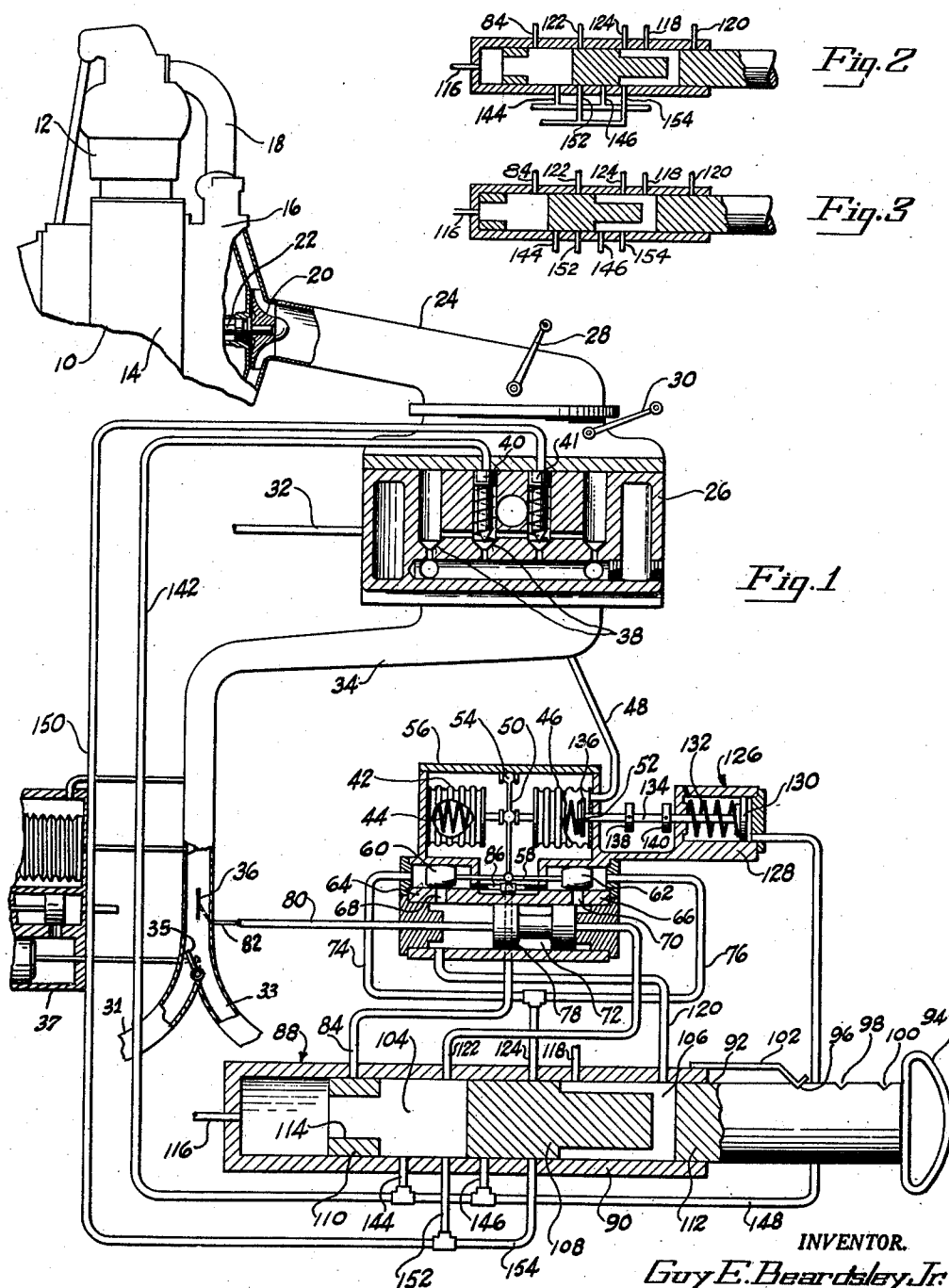


Fig. 2

Fig. 3

Fig. 1

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FUEL FEEDING DEVICE FOR ENGINES

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This invention relates to improvements in fuel feeding devices for engines having particular reference to an improved device for regulating the ratio of fuel to air in the combustible mixture fed to an internal combustion engine and has for an object the provision, in combination with the fuel feeding mechanism of an internal combustion engine such as is ordinarily used for the propulsion of aircraft and operated under different conditions of atmospheric temperature and pressure, of means for automatically maintaining the ratio of fuel to air in the combustible mixture fed to the engine such as to afford the most efficient operation of the engine. A more specific object resides in the provision in combination with the fuel feeding mechanism of an aircraft engine of an automatic device for maintaining the ratio of fuel to air in the combustible mixture fed to the engine substantially constant between different predetermined levels of flight and in the provision of additional means for altering the effect of the control means to accommodate the same to other levels of flight.

In the accompanying drawing in which like reference numerals are used to indicate similar parts throughout we have illustrated a suitable mechanical embodiment of what is now considered to be the preferred form of the invention. It is to be understood, however, that the drawing is for the purpose of illustration only and is not to be taken as limiting the invention, the scope of which is to be measured entirely by the scope of the appended claims.

In the accompanying drawing, Fig. 1 is a schematic view of a fragmentary portion of an internal combustion engine showing a control device constructed according to the idea of this invention, applied thereto, certain parts of the control device being shown in section to better illustrate the construction thereof. Fig. 2 is a partly schematic vertical sectional view of the selector valve illustrated in Fig. 1 showing the valve in a different operative position from that illustrated in Fig. 1, and Fig. 3 is a sectional view of the selector valve similar to the views illustrated in Figs. 1 and 2 showing the valve in an operative position different from the positions shown in Figs. 1 and 2.

It is a well-known fact that in the operation of airplanes powered by internal combustion engines of the electric ignition or Otto cycle type, requiring a carburetor for mixing a volatile fuel with air to provide a combustible mixture for the engine, it has been found necessary to adjust the amount of fuel supplied by the carburetor when

the aircraft is flown at high levels of flight. This operation is commonly referred to in the art as leaning out the carburetor and is necessitated by the well-known physical law that, whereas the weight of air supplied to the engine is directly proportionate to the density of the air, the amount of fuel picked up by the air as it flows through the Venturi throat of the carburetor is directly proportionate to the square root of the density of the air which results in a greater proportionate amount of fuel, or a richer mixture at high altitudes if no means are provided to correct the air-fuel ratio. Airplanes have been conventionally provided with a fuel mixture control operable by the pilot to change the air-fuel ratio to compensate for decreases in atmospheric pressure with increases in the height of the flight level of the airplane. Recently automatic means have been proposed for performing this operation without the necessity of attention from the pilot, two such automatic means being illustrated in the patent of Thorp Hiscock, No. 2,082,397, issued June 1, 1937, and the patent of Wright A. Parkins and Guy E. Beardsley, Jr., No. 2,102,504, issued December 14, 1937.

As airplanes are commonly flown at a flight level or pressure altitude of several thousand feet above sea level, the practice has grown up among manufacturers of airplane engines of building engines which develop their rated power when surrounded by atmosphere having a pressure equivalent to the determined pressure of the atmosphere at an altitude considered to be desirable for the average flight altitude at which the aircraft equipped with the particular engines will be flown. At present some engines are designed to develop their maximum rated horsepower at an altitude of around 7,000 or 8,000 feet above sea level. This means, of course, that such an engine can not be operated at sea level at full throttle without such an increase in engine power as would prove highly detrimental to the engine if continued for any prolonged period of time. Such engines must, therefore, be throttled down when they are operated under sea level conditions, or at an altitude materially lower than the altitude at which they develop the maximum power for which they are designed, and it has been common practice to depend upon the pilot to protect the engine under his operation by maintaining it partially throttled when below such altitude.

The present invention provides for the automatic control of the fuel-air ratio of the combustible mixture fed to the engine at all pressure altitudes of flight up to the maximum pressure al-

5 titude for which the device is designed and also provides for the regulation of the amount of combustible mixture fed to the engine so that the engine will not be dangerously over-powered at low pressure altitudes, a pressure altitude being the altitude corresponding to a given pressure in a standard atmosphere. The device also provides for an emergency setting which will permit a full-throttle operation of the engine at low altitudes
 10 in case the pilot considers this operation necessary for safety or some other emergency condition. The control means may also be provided with a device for automatically regulating the temperature of the air passing through the carburetor as illustrated in the Hiscock Patent No. 2,082,397 issued June 1, 1937, referred to above, so that the device will control the air-fuel ratio in accordance with the density of the air at the particular flight level at which it is operating.
 15 rather than in accordance with the pressure of the air only as would be the case if no temperature control were used.

Referring to the drawing in detail, the numeral 10 generally indicates an internal combustion engine which may be of the radial air-cooled type commonly employed for the propulsion of airplanes. The engine may have a plurality of cylinders 12 arranged about a substantially circular crankcase 14 and may be provided with a blower section 16 secured upon one face of the crankcase and connected to the individual cylinders by suitable intake pipes as indicated at 18. In the type of engine illustrated, the blower section contains an impeller or fan 20 having a suitable driving connection with the engine as by being geared to to the rear end of the engine crankshaft 22. The blower section 16 is pneumatically connected through an intake duct 24 with a carburetor generally indicated at 26. The carburetor 26 has a
 40 manually operable throttle valve 28, a manually actuable mixture control device 30, and is supplied with the usual float chamber, main jet, idling and accelerating jets, an acceleration well, and other conventional elements which have been omitted from the present drawing for the sake of clearness. Fuel is led into the carburetor through a suitable fuel conduit or gasoline line 32 and air is led into the carburetor through a suitable air inlet 34 which comprises a tubular member sealed to one end of the carburetor. At the end opposite the carburetor the air inlet 34 may be connected with a source 31 of warm air and a source 33 of cold air, and the connection to these separate air sources may be controlled by a suitable valve 35 which may be automatically actuated by a temperature responsive device 37, all as particularly set forth in the Hiscock Patent No. 2,082,397 referred to. When the temperature control is operating to maintain the carburetor intake air at a substantially constant temperature, the improved regulating device of the present invention will act to control the density of the intake air, while, if the temperature control is not operative, the pressure only of the intake air will
 65 be automatically controlled.

In order to accomplish the objects described above, of regulating both the fuel-air ratio of the combustible mixture fed to the engine and also the amount of such combustible mixture fed to the engine, it has been found desirable to definitely control the pressure or density of air flowing through the carburetor and to regulate the amount of fuel in proportion to the amount of air. This is accomplished by providing in the carburetor air intake 34, a suitable, automatically

controlled valve, 36, and in the carburetor 26 a plurality of metering jets, generally indicated at 38, including one or more automatically controllable metering jets as indicated at 40 and 41. As the power output of the engine is proportional to the air flow through the carburetor, and as this air flow can be controlled by controlling the pressure in the carburetor air intake, and as with a given carburetor the proportion of fuel to air in the air-fuel ratio is determined by the pressure in the carburetor air intake, the valve 36 and the metering jets 40 and 41 may be actuated by a pressure responsive device pneumatically connected with the interior of the carburetor air intake to limit the maximum power output of the engine and maintain the fuel-air ratio substantially constant. Such a device may be suitably arranged by providing a variable chamber, preferably in the form of an expansible bellows of the siphon type as indicated at 42, having the interior thereof exhausted to provide a vacuum therein and urged to an expanded condition against the pressure of the surrounding air by a suitable means such as the coiled spring 44, preferably contained within the bellows; and a similar bellows 46 opposed to the bellows 42 and pneumatically connected with the interior of the carburetor air intake 24 by suitable means such as the conduit 48, the two bellows being connected to a movable lever 50. As the two bellows 42 and 46 are of the same size and are opposed to each other, and are sealed against invasion of surrounding air, changes in the pressure of the atmosphere surrounding the two bellows will have no effect thereon to cause them to move the lever 50. The bellows 46 is also provided with an internally located coiled compression spring 52 which, combined with the pressure inside the bellows 46, reacts against the pressure of spring 44 to maintain the lever 50 in a balanced condition between the two springs so that if the pressure inside the bellows 46 changes, the bellows 46 will expand or contract and cause a compensatory expansion or contraction of the bellows 42 and a consequent movement of the lever 50. The expansion and contraction of the bellows 46, in response to changes in the internal pressure of the air intake 34, may be controlled by the loading of the compression spring 52, preferably located within the bellows 46, and loaded to restrain the bellows 46 against collapse until the pressure within the carburetor air intake has dropped to a certain predetermined degree based on the air pressure at the altitude for which the device is set.

In the device illustrated, the upper end of the lever 50 is pivoted as indicated at 54 to the top of the casing 56 surrounding and supporting the bellows 42 and 46 and the lower end of the lever is operatively connected to a shaft 58 which carries upon its opposite ends valve pistons 60 and 62 reciprocally mounted in valve cylinders 64 and 66 respectively, formed in the lower portion of the casing 56. The valve chambers 64 and 66 are connected through suitable ports, 68 and 70, with the interior of a cylinder 72 formed in the lower end of the casing 56 below the valve cylinders 64 and 66, the ports leading into the cylinders adjacent to the opposite ends thereof. The outer ends of the valve cylinders 64 and 66 are connected with conduits 74 and 76 respectively which contain a fluid under pressure such as engine lubricating oil. A piston 78 is reciprocal in the cylinder 72 and connected by means of a piston rod 80 and linkage 82 with the valve 36 so that when the valve pistons 60 and 62 are moved under the

actuation of the bellows 46 to connect one of the valve ports 68 or 70 with its respective pressure line 74 or 76, fluid under pressure will be admitted into the cylinder 72 upon one side of the piston 78 and cause the piston to move to the opposite end of the cylinder and thereby change the setting of the valve 36. The pressure fluid is exhausted from the cylinder 72 through a suitable drain line 84 connected to the inner ends of the valve chambers 64 and 66 by a tube 86.

From the above description it will be observed that when the pressure in the carburetor air intake 34 is above that for which the device is set the spring 52 will expand the bellows 46 and move the lower end of the lever 50 and the shaft 58 to the left as viewed in Fig. 1, thus connecting the valve port 70 with the pressure line 76 and forcing the piston 78 to the left to close, or partly close, the valve 36 and reduce the pressure in the air intake. When the pressure in the air intake is below that for which the spring 52 is loaded, the bellows 46 will collapse and the force exerted by the spring 44 will move the lower end of the lever 50 and the shaft 58 to the right as viewed in Fig. 1, thereby connecting the valve port 68 with the pressure line 74 to admit fluid under pressure into the cylinder 72 to move the piston 78 to the right, thereby opening the valve 36 to increase the pressure in the carburetor air intake. When the valves 66 and 62 are moved in one direction to admit pressure to one end of the piston 78 they, at the same time, connect the space adjacent to the opposite end of the piston 78 with the drain through the conduit 84 to relieve any pressure in the cylinder that might oppose movement of the piston 78. The construction so far described will then maintain the pressure in the carburetor air intake 34 at the pressure for which the spring 52 is set.

In order to change the setting of the automatic control device, we have provided a manually operable selector valve generally indicated at 88. In this selector valve a cylinder 90 reciprocally receives a piston or plunger 92, one end of which is operatively connected with a manual control device 94 positioned within easy reach of the operator of the vehicle. The selector valve may have any desired number of operative positions, but in the form of the invention illustrated, three positions are provided, and preferably, these three positions of the valve are indicated to the operator by suitable means such as the three spaced indentations 96, 98, and 100, into which the spring 102 engages to definitely locate the selector valve in the operative position selected.

The piston 92 has two elongated slots there-through as indicated at 104, and 106, separated by a partition 108, and terminated by valve cylinders or pistons 110 and 112 respectively. The slot 104, adjacent to the closed end of the cylinder, is connected with the interior end portion of the cylinder by a passageway 114 extending through the piston 110 and the end of the cylinder is connected with a drain line 116 for a purpose which will presently appear. The slot 106 is formed as an elongated annular groove in the valve plunger so that the pressure of the fluid supplied to the valve will build up entirely around the valve plunger and maintain the same in a centered condition and avoid any binding friction on one side of the plunger as would be the case if the slot 106 were provided on one side only of the plunger. A pressure line 118, leading directly from a source of fluid under pressure, such as the engine oil pump, is led into the

cylinder 90 at a location spaced somewhat less than half-way from the open or right hand end thereof as viewed in Fig. 1. A conduit 120 leads from a position in the cylinder 90 to the right of the pressure line 118 to the left hand end of the cylinder 72, the inlets of the conduits 118 and 120 being spaced apart a distance slightly less than the length of the slot 106. In the position of the selector valve as illustrated in Fig. 1, the pressure line 118 is hydraulically connected with the conduit 120 through the slot 106, thereby admitting pressure into the cylinder 72 to force the piston 78 to the right to open the valve 36. This position of the selector valve operates to take the actuation of the valve 36 away from the control of the bellows 42 and 46, and constitutes what was referred to above as the emergency setting of the selector valve by means of which the pilot is enabled to operate the engine at full throttle at any altitude. A drain line 122 connected into the right hand end of the cylinder 72 leads to the cylinder 90 and is connected into the cylinder 90 in a position to the left of the pressure line 118, and spaced therefrom so as to open into the slot 104 when the selector valve is in the position illustrated in Fig. 1, this arrangement serving to drain any fluid which may be contained between the right hand end of the piston 78 and the right hand end of the cylinder 72, through the conduit 122, the slot 104, the passageway 114, and the drain line 116, so that the piston may move to the right under the influence of the pressure of the fluid flowing through the line 120. The valve drain line 84 is connected to the cylinder 90 at a location to the left of the connection of the pressure line 118 and is so spaced from the pressure line that in the position of the valve as illustrated in Fig. 1, it is closed by the valve piston 110 so that any pressure which might flow into the valves 66 and 62 from the conduit 120 will be blocked off so that pressure fluid will not escape from the cylinder 72 into the drain. The conduits 74 and 76 which supply the motivating pressure to the piston 78 when the piston is under the control of the valves 60 and 62 are led together to a single line 124 which is led into the cylinder 90 at a position spaced immediately to the left of the pressure line 118 and so spaced therefrom that when the selector valve is in the position illustrated in Fig. 1 the line 124 is blocked by the partition 108 so that no pressure is supplied through the lines 74 and 76 to the valve mechanism 60 and 62 to actuate the piston 78.

A spring loading device, generally indicated at 126 and comprising a cylinder 128, a piston 130 reciprocal in the cylinder and urged in one direction by a coiled compression spring 132, is located immediately to the right of the bellows 46 and the piston 130 is connected through a shaft 134 with a disc shaped base 136 which supports the right hand end of the spring 52 so that the reciprocation of the piston 130 in the cylinder 128 will serve to change the loading on the spring 52. Preferably a pair of stops 138 and 140 are secured on the shaft 134 to limit the movements of the piston 130, these stops being adjustable to provide a certain desired change in the loading of the spring 52. A hydraulic conduit 142 leads from the metering jet control mechanism 40 to a pair of spaced connections 144 and 146, let into the cylinder 90 as illustrated in Fig. 1, on the side thereof opposite the pressure line 118, and this line is continued by the conduit 148 to the right hand end of the cylinder 128. A second conduit 75

150 leads from the metering jet control mechanism 41 to a pair of spaced connections 152 and 154 let into the cylinder 90 on the opposite side thereof from the pressure line 118. All of the connections 144, 146, 152, and 154 are located to the left of the position of the pressure line 118 and are spaced close together with the connection 146 between the connections 152 and 154, and the connection 152 between the connections 144 and 146, the distance between these connections being such that in the position of the selector valve illustrated in Fig. 1, the connections 146 and 154 are closed by the partition 108 and the connections 144 and 152 are connected through the slot 104 and passageway 114 with the drain 116 thereby relieving any pressure on the metering jet control mechanism 40 and 41 and permitting these mechanisms to open to supply additional fuel to the engine to enrich the mixture, and relieve any pressure behind the piston 130 of the spring loading device 126.

In the position of the selector valve illustrated in Fig. 2 the valve is set for operation of the engine at an intermediate altitude which may be around 6,000 or 7,000 feet and somewhere near the altitude at which the engine is designed to develop its maximum rated horsepower. In this position of the selector valve, the conduit 120 is closed by the selector piston 112, the valve pressure line 124 is connected with the pressure supplying line 118 through the slot 106. The drain line 122 is closed by the partition 108 and the valve drain line 34 is connected with the drain line 116 through the slot 104 and passageway 114, thus placing the actuation of the valve 36 under the control of the bellows 42 and 46. In this position of the parts, fluid under pressure is supplied to the valve cylinders 54 and 66 and upon movement of the valve pistons 60 and 62 by the bellows 42 and 46, this pressure will be transmitted to the corresponding side of the piston 78 to move this piston in the cylinder 72 in response to changes in the pressure of the air in the carburetor air intake 34 and actuate the valve 36 to maintain such pressure constant. The valve pistons 60 and 62 are somewhat tapered in form to provide a dampening effect on the piston 78 as it approaches the position in which the associated valve 36 provides the desired pressure in the intake 34 to thereby avoid hunting of the control mechanism. In this same position of the selector valve, connection 154 is connected with the pressure supply line 118 through the slot 106, the connections 146 and 152 are closed by the partition 108 and connection 144 remains connected to the drain through the slot 104 and passageway 114. Pressure from the pressure supply line 118 flowing through the connection 154 of the conduit 150, operates to close the metering jet control mechanism 41 and thereby diminishes the amount of fuel supplied to the engine to automatically lean out the combustible mixture to compensate for the change in altitude of the flight level.

In the position of the selector valve illustrated in Fig. 3, the valve has been set for high altitude operation. In this position the plunger 92 has been moved to its limiting left hand position, thereby connecting the valve pressure line 124 and the connections 154 and 146 to the pressure supplying line 118, the valve drain line 34 remains connected with the drain, the line 120 remains closed by the selector valve piston 112 and the drain line 122 remains closed by the partition 108 to maintain the valve 36 under the control

of the bellows 42 and 46. The connection 154 also remains in connection with the pressure line 118 to maintain the metering jet control mechanism 41 closed. The principal change which is accomplished by this shift in the position of the selector valve is that the connection 146 is now connected with the pressure line 118 through the slot 106 and the connection 144 is closed by the partition 108. Fluid under pressure flowing through the connection 146 and the lines 142 and 148 will close the metering jet control mechanism 40, thereby further leaning the mixture for the high altitude operation and will build up pressure behind the piston 130 in the spring loading device 126 to move this piston to its left hand limiting position and thereby place an increased loading on the spring 52 to alter the operation of the bellows 46 so that the bellows will now operate to maintain constant a lower pressure in the air intake 34, that is, it will require a materially lower absolute pressure in air intake 34 to cause the control mechanism to open the valve 36 than was necessary to cause this operation with the setting of the selector valve illustrated in Fig. 2. Thus, in the setting of the selector valve as illustrated in Fig. 3, the carburetor is adjusted for high altitude operation by maintaining a lower absolute pressure in the carburetor air inlet 34 and by further reducing the amount of fuel supplied by the carburetor to maintain the air-fuel ratio substantially constant at the ratio desired for the reduced amount of air.

From the above description it will be observed that we have provided an improved device for automatically protecting an altitude rated engine against danger due to accidental operation at excessive power at low altitudes and have also provided in the same device, means for maintaining the air-fuel ratio of the combustible mixture constant at different altitudes within the range of operation of the airplane.

While we have illustrated and described a particular mechanical embodiment of the idea of the invention, it is to be understood that the invention is not limited to the specific mechanical embodiments so illustrated and described, but that such changes in the size, shape and arrangement of parts may be resorted to as come within the scope of the appended claims.

As we have now illustrated and described our invention so that others skilled in the art may clearly understand the same, what we desire to secure by Letters Patent is as follows:

1. In combination with an internal combustion engine and a carburetor therefor, means for maintaining the proportion of fuel to air in the combustible mixture produced by said carburetor substantially constant in varying atmospheric pressures said means comprising, means responsive to the air density within the air intake of said carburetor for automatically maintaining said density substantially constant at a predetermined value, operator controlled means for controlling said automatic means to selectively maintain the air density in said intake at a different predetermined value, and means actuated by said controlling means for automatically correcting the fuel metering setting of said carburetor to supply the same fuel-air ratio at the changed air density.

2. In combination with an internal combustion engine, a carburetor for supplying a combustible mixture to said engine, and an air intake for said carburetor, means for regulating the absolute pressure of the air in said air intake, automatic

means responsive to the pressure of the air in said intake for controlling said regulating means to maintain said pressure constant at any one of a plurality of predetermined degrees of pressure, manual means for adjusting said automatic means to provide in said intake any selected one of said degrees of pressure, and means under the control of said manual means for controlling the amount of fuel supplied by said carburetor to said combustible mixture to maintain the proportion of fuel to air in said combustible mixture constant for all settings of said automatic means.

3. In combination with an internal combustion engine, a carburetor for supplying a combustible mixture to said engine, and an air intake for said carburetor, a valve in said air intake for regulating the absolute pressure of the air in said intake, automatic means responsive to the pressure of the air in said intake for controlling said valve to maintain said pressure constant at any one of a plurality of predetermined degrees of pressure, manually actuatable means for adjusting said automatic means to provide in said intake any selected one of said degrees of pressure, and means under the control of said manual means for controlling the amount of fuel supplied by said carburetor to said combustible mixture to maintain the proportion of fuel to air in said combustible mixture constant for all settings of said automatic means.

4. In combination with an internal combustion engine, a carburetor for supplying a combustible mixture to said engine, and an air intake for said carburetor, a valve in said intake for regulating the absolute pressure of the air in said air intake, an expansible chamber responsive to the pressure of the air in said intake, an hydraulically actuated piston operatively connected to said valve and actuated by said expansible chamber for controlling said valve to maintain said pressure constant at any one of a plurality of predetermined degrees of pressure, manual means for controlling said automatic means to provide in said intake any selected one of said degrees of pressure and means under the control of said manual means for controlling the amount of fuel supplied by said carburetor to said combustible mixture to maintain the proportion of fuel to air in said combustible mixture constant for all settings of said automatic means.

5. In combination with an internal combustion engine, a carburetor for supplying a combustible mixture to said engine and an air intake for said carburetor, a valve in said intake for regulating the absolute pressure of the air in said intake, a pair of spring pressed balanced expansible chambers responsive to the pressure of the air in said intake, an hydraulically operated piston operatively connected to said valve and actuated by said expansible chambers for controlling said valve to maintain said pressure constant at any one of a plurality of predetermined degrees of pressure, a manually actuatable control valve hydraulically connected with said expansible chambers for adjusting said chambers to provide in said intake any selected one of said predetermined degrees of pressure, and a plurality of metering jet operating mechanisms in said carburetor hydraulically connected with said manually operable means for controlling the amount of fuel supplied by said carburetor to said combustible mixture to maintain the proportion of fuel to air in said combustible mixture constant for all settings of said expansible chambers when

said manually actuatable valve is actuated to change the setting of said expansible chambers.

6. In an airplane, in combination with an internal combustion engine and a carburetor therefor, means for maintaining the proportion of fuel to air in the combustible mixture fed by said carburetor to said engine constant at any one of a plurality of air density values corresponding to the air density at a selected flight level and for limiting the maximum power output of said engine to the maximum power output at said selected flight level, said means comprising, means for regulating the amount of fuel flowing through said carburetor, means for regulating the amount of air flowing through said carburetor, means responsive to the pressure of the air in said carburetor for controlling said air regulating means to maintain said pressure constant at the selected value, manually operable means for adjusting said pressure responsive means to maintain said pressure constant at any selected one of said air density values corresponding to the air density at a selected flight level and for controlling said fuel regulating means to maintain the proportion of fuel to air constant at all of said selected air pressure values.

7. In combination with an internal combustion engine, a carburetor for supplying a combustible mixture to said engine and an air intake for said carburetor, means for limiting the maximum power output of said engine to the maximum power output at a selected flight level and for automatically maintaining the proportion of fuel to air in the combustible mixture fed by said carburetor to said engine substantially constant at all flight levels, said means comprising, a valve in said air intake for regulating the absolute pressure of the air in said intake, a pair of spring-pressed balanced expansible chambers responsive to the pressure of the air in said intake, hydraulic means operatively connecting said expansible chambers with said valve to actuate said valve to open and close said intake in response to the effect on said expansible chambers of changes in the pressure of the air in said intake to maintain said pressure constant, manual means for controlling the action of said expansible chambers to provide in said intake any selected one of said degrees of pressure, and means under the control of said manual means for controlling the amount of fuel supplied by said carburetor to said combustible mixture to maintain the proportion of fuel to air in said combustible mixture constant for all values of absolute pressure maintained in said carburetor intake.

8. In combination with an internal combustion engine, a carburetor for supplying a combustible mixture to said engine and an air intake for said carburetor, a valve in said air intake for regulating the absolute pressure of air in said intake, automatic means responsive to the pressure of the air in said intake for controlling said valve to maintain said pressure constant at any one of a plurality of predetermined pressure values, hydraulically actuated means operatively connecting said automatic means with said valve, a plurality of metering jet operating mechanisms in said carburetor for controlling the amount of fuel supplied by said carburetor, and manually actuatable means comprising, a cylinder, a manually actuatable piston reciprocable in said cylinder, and means connecting said cylinder with said automatic means and with said metering jet operating mechanisms for selecting the pressure value of the air in said carburetor intake and

regulating the proportion of fuel to air in the combustible mixture fed by said carburetor to said engine.

9. In combination with an internal combustion engine, a carburetor for supplying a combustible mixture to said engine and an air intake for said carburetor, a valve in said intake for regulating the absolute pressure of the air in said air intake, an expansible chamber responsive to the pressure of the air in said intake, a hydraulically actuated piston operatively connected to said valve and actuated by said expansible chamber for controlling said valve to maintain said pressure constant at any one of a plurality of predetermined degrees of pressure, means for controlling the amount of fuel supplied by said carburetor to said combustible mixture, and manual means comprising a cylinder hydraulically connected with said hydraulically actuated piston, with said fuel controlling means, with a drain, and with a source of fluid under pressure, and a manually actuable piston reciprocable in said cylinder to control the action of said hydraulically actuated piston to maintain said valve open or to place it under the control of said expansible chamber and to actuate said fuel control means to maintain the proportion of fuel to air in said combustible mixture constant.

10. In an airplane, in combination with an internal combustion engine, and a carburetor therefor, means for limiting the maximum power output of said engine to the maximum power output at atmospheric pressures corresponding to a plurality of predetermined flight levels and for maintaining the proportion of fuel to air in the combustible mixture fed by said carburetor to said engine substantially constant at atmospheric pressures corresponding to all of said predetermined flight levels said means comprising, means for regulating the flow of air to said carburetor, means for regulating the flow of fuel to said carburetor, means spring urged in one direction and responsive to the pressure of air within said carburetor to actuate said air regulating means to maintain the absolute pressure of the air in said carburetor constant at a selected value, and manually operable means operatively connected with said fuel control means and said air regulating means and having a plurality of operative positions in one of which positions said manually operable means actuates said fuel regulating means and said air regulating means to a position to supply the maximum quantities of fuel and air available to said carburetor and in said other positions places said air regulating means under the control of said pressure responsive means, adjusts the loading on the spring of said pressure responsive means to select one of said predetermined air pressure values and controls said fuel regulating means to maintain the air-fuel ratio for the pressure value selected the same as the air-fuel ratio for the remainder of said predetermined pressure values.

11. In combination with an airplane engine for operation under atmospheric pressures varying from the atmospheric pressure at sea level to the atmospheric pressure at the ceiling of the airplane and designed to furnish its maximum rated horsepower at an atmospheric pressure corresponding to an altitude intermediate sea level and the ceiling of said airplane, means for automatically limiting the horsepower output of said engine when operating at an atmospheric pressure greater than the pressure corresponding to said intermediate altitude said means comprising, a carburetor, a valve associated with said carburetor for regulat-

ing the flow of air therethrough, control means responsive to the pressure in said carburetor for actuating said valve to maintain a selected predetermined pressure in said carburetor, and operator controlled means for selectively rendering said control means effective or ineffective to actuate said valve.

12. In combination, a carburetor adapted to maintain a constant fuel-air ratio in an atmosphere of a constant density and having a plurality of controllable fuel jets, means for maintaining the air pressure in the carburetor inlet at a predetermined value, said means comprising a valve controlling said inlet, an expansible chamber device responsive to the pressure in said inlet for operating said valve, resilient means opposing movement of said expansible chamber device in response to a change of pressure in said inlet, means for adjusting said resilient means to maintain a different predetermined pressure in said inlet and a control for said jets and said resilient means for adjusting said resilient means and simultaneously closing a predetermined number of the controllable fuel jets to maintain said fuel-air ratio the same at the lower air density.

13. In combination, a carburetor adapted to maintain a predetermined fuel-air ratio in an atmosphere of a constant density and having a plurality of controllable fuel jets, means for maintaining the air pressure in the carburetor inlet at a predetermined value, said means comprising a valve controlling said inlet, an expansible chamber device responsive to the pressure in said inlet for operating said valve, a spring acting to oppose movement of said expansible chamber device in response to a decrease in pressure in said inlet, and a movable abutment for one end of said spring to regulate said means to maintain a different predetermined pressure in said inlet, and a control for said means and said jets, said control comprising mechanism for moving said abutment to maintain a predetermined reduced pressure in said inlet and also for closing a predetermined number of the controllable fuel jets in said carburetor to maintain the same fuel-air ratio at the reduced pressure.

14. In combination with a carburetor having an air inlet, controllable normally open fuel jets, and means for maintaining constant the density of air in the carburetor air inlet, a single selector valve adapted in one position to disable said density controlling means and in another position to render said density controlling means effective to maintain a predetermined pressure in said air inlet and to close a predetermined number of said jets.

15. In combination with a carburetor having a plurality of normally open fuel jets and adapted to produce a predetermined fuel-air ratio at a constant air density, means including an adjustable pressure responsive device, for maintaining the density of the air in the carburetor inlet constant at any selected one of a plurality of predetermined values, a single control for said carburetor and said means adapted in one position to disable said means in another position to close a predetermined number of said jets and render said means operative to maintain a predetermined density of the air in said carburetor inlet and in still another position to close a predetermined additional number of said jets and adjust said pressure responsive device to maintain the density of the air in said carburetor inlet constant at a lower predetermined value.

16. A control for an engine designed to operate

- within a broad range of pressure altitudes comprising, a plurality of individual means for automatically controlling the intake of said engine each operative up to a respective preselected pressure altitude, and means for selectively rendering any one of said individual means effective to control the intake of said engine at any pressure altitude at which the selected means is operative.
- 10 17. A carburetor control for an engine designed to operate on a constant ratio air-fuel mixture comprising a plurality of individual means for automatically controlling the intake of said carburetor in different respective pressure altitude ranges to maintain said fuel-air ratio constant, and means for selectively rendering any one of said individual means effective to control the carburetor intake within the pressure altitude range of the selected means.
- 15 18. A carburetor control for an aircraft engine comprising, means including a fuel control jet, an air valve and a pressure responsive device and a servo-motor operative to automatically control the intake of said carburetor up to one predetermined pressure altitude, means including a second fuel control jet and an adjusting mechanism for said pressure responsive device operative to automatically control the intake of said carburetor up to a second predetermined pressure altitude, and means for selectively rendering either of said automatic control means effective to control the intake of said carburetor at any pressure altitude at which the selected means is operative.
- 20 19. A carburetor control for an aircraft engine comprising, means including a fuel control jet, an air valve and a pressure responsive device and a servo-motor operative to automatically control the intake of said carburetor up to one predetermined pressure altitude, means including a second fuel control jet and an adjusting mechanism for said pressure responsive device operative to automatically control the intake of said carburetor up to a second predetermined pressure altitude, and means for selectively rendering either of said automatic control means effective to control the intake of said carburetor at any pressure altitude at which the selected means is operative or to render both of said automatic control means ineffective to control the intake of said carburetor.
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