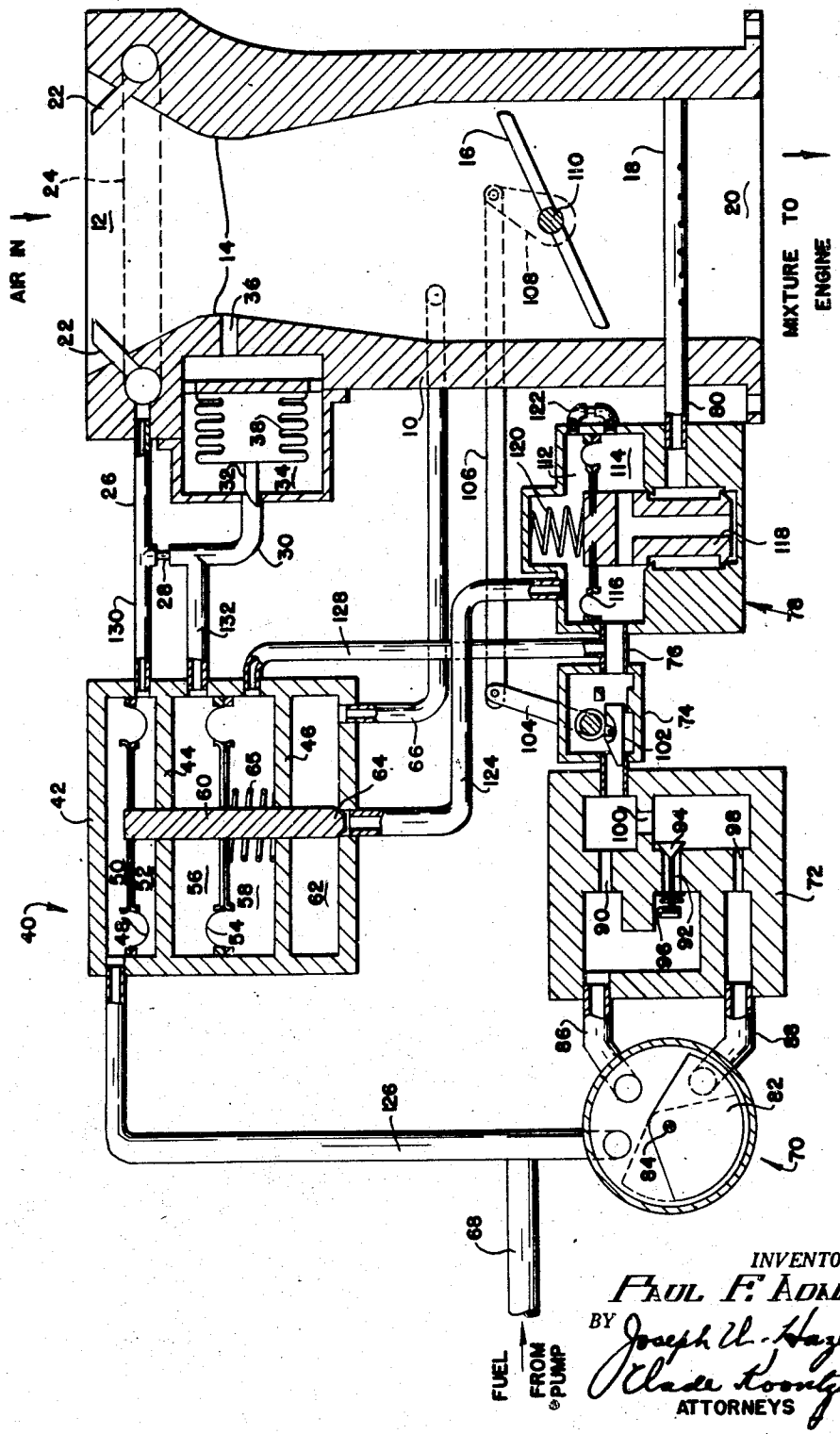
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CARBURETOR

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CARBURETOR

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The invention described herein may be manufactured and used by or for the Government for governmental purposes, without the payment to me of any royalty thereon.

The present invention is related to carburetors for internal combustion engines, and particularly to pressure type carburetors such as are in current use on aircraft engines, in which the fuel is injected into the stream of combustion air flowing to the engine under a pressure greater than that of the air with which it is mixed.

It is an object of the present invention to provide an improved carburetor of the type described, wherein the fuel pressure drop thru the carburetor is maintained at a minimum, thereby reducing the possibility of formation of vapor in the fuel line.

Another object of the present invention is to provide an improved carburetor of the type described in which changes of the pressure of the fuel supplied to the carburetor will not affect the fuel-to-air ratio.

Another object is to provide, in a carburetor including a main fuel flow controlling valve and a pilot valve for regulating the main valve in response to the unbalance between air and fuel flows, an improved pilot valve construction such that the pilot valve is not affected by fuel pressure changes directly from its own operation, but only by fuel pressure changes resulting from operation of the main valve.

A further object of the present invention is to provide an improved carburetor including a fuel regulator unit which is interchangeable between different sizes of carburetors.

Another object of the present invention is to provide an improved carburetor of a simplified and compact construction, using a minimum number of parts.

Other objects and advantages of the present invention will become apparent from a consideration of the appended specification, claims and drawing, in which

The single figure represents, somewhat diagrammatically, a carburetor for an internal combustion engine embodying the principles of my invention.

Referring to the drawing, there is shown a carburetor including an air conduit 10. Air enters the conduit 10 at an inlet 12 and flows thru a Venturi restriction 14, past a throttle 16 and a fuel discharge nozzle 18 to an outlet 20. A supercharger may be placed between the outlet 20 and the intake manifold of the engine upon which the carburetor is mounted. In certain

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cases the supercharger may be upstream from the inlet 12, or two superchargers may be used, one in each place.

The Venturi restriction 14 produces a pressure differential between the inlet 12 and the throat of the venturi which varies substantially in accordance with the square of the velocity of the air passing thru the venturi. Since the cross-sectional area of the venturi is constant, this pressure differential may be taken as a measure of the volume of air flowing thru the passage per unit time.

The pressure differential set up by the venturi 14 is utilized to create a flow of air thru a secondary air passage. The air enters this secondary air passage thru a plurality of tubes 22, whose ends are open to receive the impact of the entering air. In the secondary air passage, the air flows from the tubes 22 thru a passage 24 interconnecting all the tubes, a conduit 26, a fixed restriction 28, a conduit 30, past a valve 32 into a chamber 34, and then thru a conduit 36 to the throat of venturi 14.

The valve 32 is operated by a sealed bellows 38 mounted in the chamber 34. The bellows 38 is fixed at one end, so that the position of the free end, to which valve 32 is attached, varies in accordance with the air pressure in the chamber 34. Bellows 38 is preferably filled with nitrogen or some other suitable temperature responsive fluid, so that the position of valve 32 varies not only with the pressure but also with the temperature of the air in the chamber 34, and hence with the density of that air.

The pressure differential produced by venturi 14 is a measure of the volume of air flowing per unit time, as previously explained. Since it is desired to obtain a measure of the mass of air flowing per unit time rather than the volume, it is necessary for the metering apparatus to correct variations in air density. This is accomplished by the valve 32 and bellows 38. The valve 32 is moved toward open position as the air density increases and toward closed position as the air density decreases.

If the volume of air flowing per unit time thru the air conduit 10 remains constant and its density decreases, then the mass of air is decreased, but the pressure differential set up by the venturi 14 remains constant. However, the movement of valve 38 toward closed position causes the flow of air through restriction 28 to decrease, so that the pressure drop across the restriction 28 is decreased to compensate for the decrease in density. The pressure drop across orifice 28 is

thereby made to measure the mass of air flowing per unit time to the air conduit 10.

A pressure meter, generally indicated at 40, includes a casing 42 whose interior is divided by two rigid transverse partitions 44 and 46. The space inside casing 42 above the partition 44 is further divided by a flexible diaphragm 48 into expansible chambers 50 and 52. The space between partitions 44 and 46 is divided by a flexible diaphragm 54 into expansible chambers 56 and 58. A valve stem 60 is attached at its center to the diaphragms 48 and 54 and extends thru central apertures in the partitions 44 and 46 into a valve chamber 62 below partition 46. The stem 60 carries at its lower end a pilot valve 64 which controls the flow of fuel into the valve chamber 62. Fuel flows freely out of the chamber 62 thru a conduit 66 leading to the air conduit 10. A spring 65 biases the valve 64 in an opening direction.

Fuel enters the carburetor from a fuel pump (not shown) or other source of fuel under superatmospheric pressure. It flows thru a conduit 68, a mixture control unit generally indicated at 70, a jet system 72, an idle valve mechanism 74, a conduit 76, a flow regulator 78, and a conduit 80 to the fuel discharge nozzle 18.

The mixture control unit 70 includes a disc valve 82 fixed on a shaft 84. The disc valve 82 controls the flow of fuel thru ports opening into conduits 86 and 88 which lead into the jet system 72. When the disc valve 82 is in the position illustrated in full lines in the drawing, fuel can flow to the jet system only thru the conduit 86. This is known as the "lean" position of the mixture control 70. When the disc valve 82 is in the dotted line position shown in the drawing, the fuel can flow thru both the conduits 86 and 88. The dotted line position is termed the "rich" position of the mixture control. The disc 84 can also be moved to a "cut-off" position wherein it cuts off the flow of fuel thru both conduits 86 and 88.

The conduit 86 conducts the fuel either thru a fixed metering restriction or jet 90, or thru a restriction 92 controlled by a valve 94 biased to closed position by a spring 96. The conduit 88 conducts fuel thru a fixed restriction 98. Fuel flowing thru the restrictions 92 and 98 also flows thru another restriction 100 which limits the total flow thru the restrictions 92 and 98.

The valve 94 is normally closed, but opens at high fuel pressure differentials across the jet system to increase the fuel-to-air ratio under heavy load conditions. It is therefore termed an enrichment valve.

The idler valve mechanism 74 includes a valve 102 pivotally attached to a lever 104, whose opposite end is connected by a link 106 to an arm 108 fixed on the shaft 110 of the throttle 16. The idle valve is normaly wide open when the throttle is beyond a range of positions near its closed position, usually termed the idling range. As the throttle moves into the idling range, thereby decreasing the air flow, the idle valve 102 moves toward closed position.

The flow regulator 78 includes a pair of expansible chambers 112 and 114 separated by a flexible diaphragm 116, which is attached at its center to a valve 118. A spring 120 biases the valve 118 toward closed position. The chambers 112 and 114 are connected by a restricted passage 122. The chamber 112 is also connected thru a conduit 124 to the valve chamber 62 of pressure meter 40. The flow of fuel into valve chamber 62 from conduit 124 is controlled by valve 64. The chamber 114 receives fuel from the conduit 76 and is an inlet chamber for the valve 118.

For any given position of the mixture control unit 70 and of the valve 94, the fuel pressure differential across the jet system 72 is a measure of the rate of flow of fuel thru that system. The fuel pressure upstream from the jet system 72 is communicated thru a conduit 126 to the chamber 50 in pressure meter 40. The fuel pressure downstream from the jet system 72 is communicated thru a conduit 128 to the chamber 58 in the pressure meter 40. Since the pressure upstream from the jet system is the greater of the two, it may be seen that this fuel pressure differential acts on the valve stem 60 in a valve closing direction.

The air pressure upstream from the restriction 28 in the secondary air passage previously described is communicated thru a conduit 130 to the chamber 52 in the pressure meter 40. The pressure downstream from restriction 28 in the secondary air passage is communicated thru a conduit 132 to chamber 56 of the pressure meter 40. Since the pressure upstream from restriction 28 is greater than the downstream pressure, it must be seen that this air pressure differential acts on the valve stem 60 in a valve opening direction.

The valve stem 60 and hence the pilot valve 64 are therefore positioned by the difference between two opposing forces, one proportional to the fuel pressure differential and hence the fuel flow, and acting on the valve in a closing direction, and the other proportional to the air flow and acting on the valve in an opening direction. A spring 65 is also provided which biases the valve 64 for movement in an opening direction.

The chamber 112 of the flow regulator 78 receives fuel thru the restricted passage 122, and fuel is discharged from chamber 112 thru the valve 64. The pilot valve 64 therefore controls the pressure in chamber 112, and thereby the opening of the main valve 118 and hence the rate of flow of fuel thru the carburetor.

Operation

The rate of flow of air thru the air conduit 10 is determined chiefly by the position of the throttle and by the speed of the engine. As the air flows thru the conduit 10, a pressure differential is produced across restriction 28 which is a measure of that air flow. This pressure differential acts in an opening direction on valve stem 60 and pilot valve 64, so that the valve 64 starts to open and continues its opening movement until that movement is arrested by the application of an equal and opposite force in a closing direction by the fuel pressure differential across the jet system, which is applied to chambers 50 and 58 of the pressure meter 40. As the pilot valve 64 is moved toward open position, the pressure in chamber 112 of flow regulator 78 is reduced. Since the pressure in chamber 114 is higher than the pressure in chamber 112, due to the restriction in passage 122, a reduction of the pressure in chamber 112 causes the main valve 118 to move toward open position, thereby increasing the fuel flow. This increase in the fuel flow continues until the force applied to valve stem 60 by the fuel pressure differential equals the opposite force applied by the air pressure differential. Movement of valves 60 and 118 then stops, and the fuel flow is established at a value proportional to the air flow.

If the fuel flow is too great for the air flow,

then the fuel pressure differential is larger than the air pressure differential, and the valve **64** moves toward closed position, increasing the pressure in chamber **112** and thereby closing the valve **118** and decreasing the fuel flow until the air and fuel pressure differentials in the pressure meter **40** are again in balance.

It should be noted that the position of the valve **64** is substantially unaffected by variations in the pressure in chamber **112**, which is controlled by valve **64**. Therefore, the valve **64** moves only when the fuel and air differential pressures are unbalanced, and continues to move until they are balanced or until the valve **64** reaches its limit of movement.

For example, if the air flow increases, causing valve **64** to open, but the main valve **118** sticks, so that the fuel flow does not increase, then the valve **64** continues to move until it is open wide, unless the valve **118** is first loosened by the increasing pressure differential acting on diaphragm **114**. When valve **64** is wide open, the pressure differential acting on diaphragm **114** is substantially the full pressure drop existing between chamber **114** and the main air passage. If the valve **118** sticks on a decreasing air flow, the valve **64** will close completely, so that there is then no pressure differential acting on diaphragm **114**, and the full force of spring **120** is brought into play to unstick the valve.

Therefore, the full force of the total pressure differential between chamber **114** and air passage **12** is always available to move the main valve in one direction, and the full force of spring **120** is always available to move it in the other direction. The force applied to move the valve is limited only by the force available, and not by the magnitude of the unbalance between the air and fuel pressure differentials.

When the throttle is in the idling range of positions near its closed position, the air pressure differential is so small that it does not provide an accurate measure of the rate of flow of air. At this time, the spring **65** is the predominating force acting in an opening direction on valve **64**. Since the force of spring **65** at this time is greater than that due to the air pressure differential, the valve **64** is opened wider than is indicated as necessary by the air pressure differential. The valve **118** is likewise opened wider, due to the reduction in pressure in chamber **112**. At this time, the idle valve **102**, which is linked to the throttle **16**, is moved toward closed position, thereby reducing the fuel flow. The effect of spring **65** is to remove the air pressure differential from the control of the fuel flow when that air pressure differential falls too low. The fuel flow is at that time controlled by the idle valve **102**, since it has been found that the throttle controlled idle valve **102** is much more reliable as a fuel flow control at low air flows.

When the valve **82** of the mixture control **70** is moved from the full line position indicated in the drawing to the dotted line position, the cross-sectional area of the path thru the jet system **72** open to the flow of fuel is increased. This increases the rate of fuel flow obtained for a given value of the fuel pressure differential. Therefore, the carburetor controls the fuel supply to provide an enriched fuel-to-air ratio when the mixture control valve **82** is in its dotted line position.

Likewise, the opening of the valve **94** in response to a high fuel pressure differential increases the cross-sectional area of the fuel flow path thru the jet system **72**, and thereby increases the fuel-to-air ratio. This enrichment at high air flows is provided to prevent detonation at high engine power outputs, and to enable the engine to run cooler under such conditions.

It may be observed that in the fuel line in my carburetor there are only two substantial pressure drops, one in the jet system **72** and one thru the valve **118**. Since I have reduced the number of pressure drops to a minimum, I have reduced the total over-all pressure drop and thereby the tendency of the fuel to vaporize in the fuel line. Also, since the first pressure drop is thru the metering orifices or jets, the absolute pressures on both sides of these jets are as high as possible consistent with given conditions as to inlet pressure and pressure drop thru the jets. Therefore, the tendency of the fuel to vaporize in the jets, where such vaporization might cause serious errors in the fuel metering, is minimized.

It should also be noted that the pressure meter **40** may be used with any size of carburetor. The dimensions of the air venturi **14** and the fuel jet system **72** might have to be varied to suit the capacities of different engines, but any given size of pressure meter **40** could be used on any size air and fuel supply system.

While I have shown and described a preferred embodiment of my invention, other modifications thereof will readily occur to those skilled in the art, and I therefore intend my invention to be limited only by the appended claims.

I claim:

1. A fuel and air proportioning device for an internal combustion engine, comprising in combination, a first conduit for conveying air for combustion purposes to said engine, means associated with said first conduit for producing two unequal air pressures whose difference is a measure of the rate of flow of air thru said conduit, means for supplying fuel under superatmospheric pressure, a second conduit for conveying fuel from said fuel supply means to said engine, a metering restriction in said second conduit effective to control the flow of fuel therethru as a function of the fuel pressure differential thereacross, a main valve for variably restricting said second conduit to control the flow of fuel therethru, an expansible chamber having a movable wall subject on its exterior surface to the fuel pressure in said second conduit, said wall being operatively connected to said main valve for positioning the same, a restricted inlet passage connecting the interior of said chamber to said second conduit, a restricted outlet passage connecting the interior of said chamber to a point maintained at a continuously lower pressure, a pilot valve for controlling one of said restricted passages, a stem for said valve, a rigid wall for said one passage, said rigid wall being apertured to permit passage of said stem therethru, and means responsive to said difference of air pressures acting on said stem outside said wall to position said valve, the unbalanced area of said pilot valve acted on by the pressure in said one passage being negligibly small as compared to the area of said air pressure difference responsive means, so that said valve is positioned in response to said air pressure difference and substantially independently of the pressure in said one passage.

2. A fuel and air proportioning device for an internal combustion engine, comprising in combination, a first conduit for conveying air for combustion purposes to said engine, means associated with said first conduit for producing two

unequal air pressures whose difference is a measure of the rate of flow of air thru said conduit, means for supplying fuel under superatmospheric pressure, a second conduit for conveying fuel from said fuel supply means to said engine, a metering restriction in said second conduit effective to control the flow of fuel therethru as a function of the fuel pressure differential thereacross, a main valve for variably restricting said second conduit to control the flow of fuel therethru, an expansible chamber having a movable wall subject on its exterior surface to the fuel pressure in said second conduit, said wall being operatively connected to said main valve for positioning the same, a restricted inlet passage connecting the interior of said chamber to said second conduit, a restricted outlet passage connecting the interior of said chamber to a point maintained at a continuously lower pressure, a pilot valve for controlling one of said restricted passages, a stem for said pilot valve, a rigid wall for said one passage, said rigid wall being apertured to permit passage of said stem therethru, and means acting on said stem outside said wall to position said pilot valve in response to the balance between the difference of said air pressures and said fuel pressure differential, the unbalanced area of said pilot valve acted on by the pressure in said one passage being negligibly small as compared to the area of said balance responsive means, so that the pilot valve is positioned in accordance with said balance and substantially independently of the pressure in said one passage, whereby a change in said difference of air pressures causes movement of said pilot valve either until said fuel pressure differential is changed to balance the change in air flow or until said pilot valve reached its limit of movement.

3. A fuel and air proportioning device for an internal combustion engine, comprising in combination, a first conduit for conveying air for combustion purposes to said engine, means associated with said first conduit for producing two unequal air pressures whose difference is a measure of the rate of flow of air thru said conduit for conveying fuel from said fuel supply means to said engine, a metering restriction in said second conduit effective to control the flow of fuel therethru as a function of the fuel pressure differential thereacross, a main valve for variably restricting said second conduit to control the flow of fuel therethru, an expansible chamber having a movable wall subject on its exterior surface to the fuel pressure in said second conduit, said wall being operatively connected to said main valve for positioning the same, a restricted inlet passage connecting the interior of said chamber to said second conduit, a restricted outlet passage connecting the interior of said chamber to a point maintained at a continuously lower pressure, a pilot valve for controlling said restricted outlet passage, a stem for said pilot valve, a rigid wall for said outlet passage, said rigid wall being apertured to permit passage of said stem therethru, and means acting on said stem outside said wall to position said pilot valve in response to the balance between the difference of said air pressures and said fuel pressure differential, the unbalanced area of said pilot valve acted on by the pressure in said one passage being negligibly small as compared to the area of said balance responsive means, so that the pilot valve is positioned in accordance with said balance and substantially independently of the pressure in said one passage, whereby if the main valve sticks and the air flow increases, the pilot valve continues to open until the full pressure differential between said conduit and said lower pressure acts on said wall to move said main valve.

4. A fuel and air proportioning device for an internal combustion engine, comprising in combination, a first conduit for conveying air for combustion purposes to said engine, means associated with said first conduit for producing two unequal air pressures whose difference is a measure of the rate of flow of air thru said conduit, means for supplying fuel under superatmospheric pressure, a second conduit for conveying fuel from said fuel supply means to said engine, a metering restriction in said second conduit effective to control the flow of fuel therethru as a function of the fuel pressure differential thereacross, a main valve for variably restricting said second conduit to control the flow of fuel therethru, an expansible chamber having a movable wall subject on its exterior surface to the fuel pressure in said second conduit, said wall being operatively connected to said main valve for positioning the same, a restricted inlet passage connecting the interior of said chamber to said second conduit, a restricted outlet passage connecting the interior of said chamber to a point maintained at a continuously lower pressure, a spring acting on said wall in opposition to the difference between the pressure in said conduit and the pressure in said chamber, a pilot valve for controlling one of said restricted passages, a stem for said pilot valve, a rigid wall for said one passage, said rigid wall being apertured to permit passage of said stem therethru, and means acting on said stem outside said wall to position said pilot valve in response to the balance between the difference of said air pressures and said fuel pressure differential, the unbalanced area of said pilot valve acted on by the pressure in said one passage being negligibly small as compared to the area of said balance responsive means, so that the pilot valve is positioned in accordance with said balance and substantially independently of the pressure in said one passage, whereby if said main valve sticks, either the full pressure differential between said conduit and said lower pressure, or the full force of said spring, is available to act on said wall and move said main valve.

5. A fuel flow controlling device for an internal combustion engine, comprising means for producing a force varying in accordance with the power output of said engine, a conduit for conveying fuel to said engine, a metering restriction in said conduit effective to control the flow of fuel therethru as a function of the fuel pressure differential thereacross, a main valve for variably restricting said conduit to vary the flow of fuel therethru, an expansible chamber having a movable wall subject on its exterior surface to the fuel pressure in said conduit, said wall being operatively connected to said main valve for positioning the same, a restricted inlet passage connecting the interior of said chamber to said conduit, a restricted outlet passage connecting the interior of said chamber to a point maintained at a continuously lower pressure, a pilot valve for controlling one of said restricted passages, a stem for said pilot valve, a rigid wall for said one passage, said rigid wall being apertured to permit passage of said stem therethru, and means acting on said stem outside said wall to position said pilot valve, said pilot valve posi-

tioning means being responsive to the balance between the force produced by said force producing means and a force due to said fuel pressure differential, the unbalanced area of said pilot valve acted on by the pressure in said one passage being negligibly small as compared to the area of said balance responsive means, so that the pilot valve is positioned in accordance with said balance and substantially independently of the pressure in said one passage, whereby a change in engine power output causes movement of said pilot valve either until said fuel pressure differential is changed to balance the change in power output or until said pilot valve reaches its limit of movement.

PAUL F. ADAIR.

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