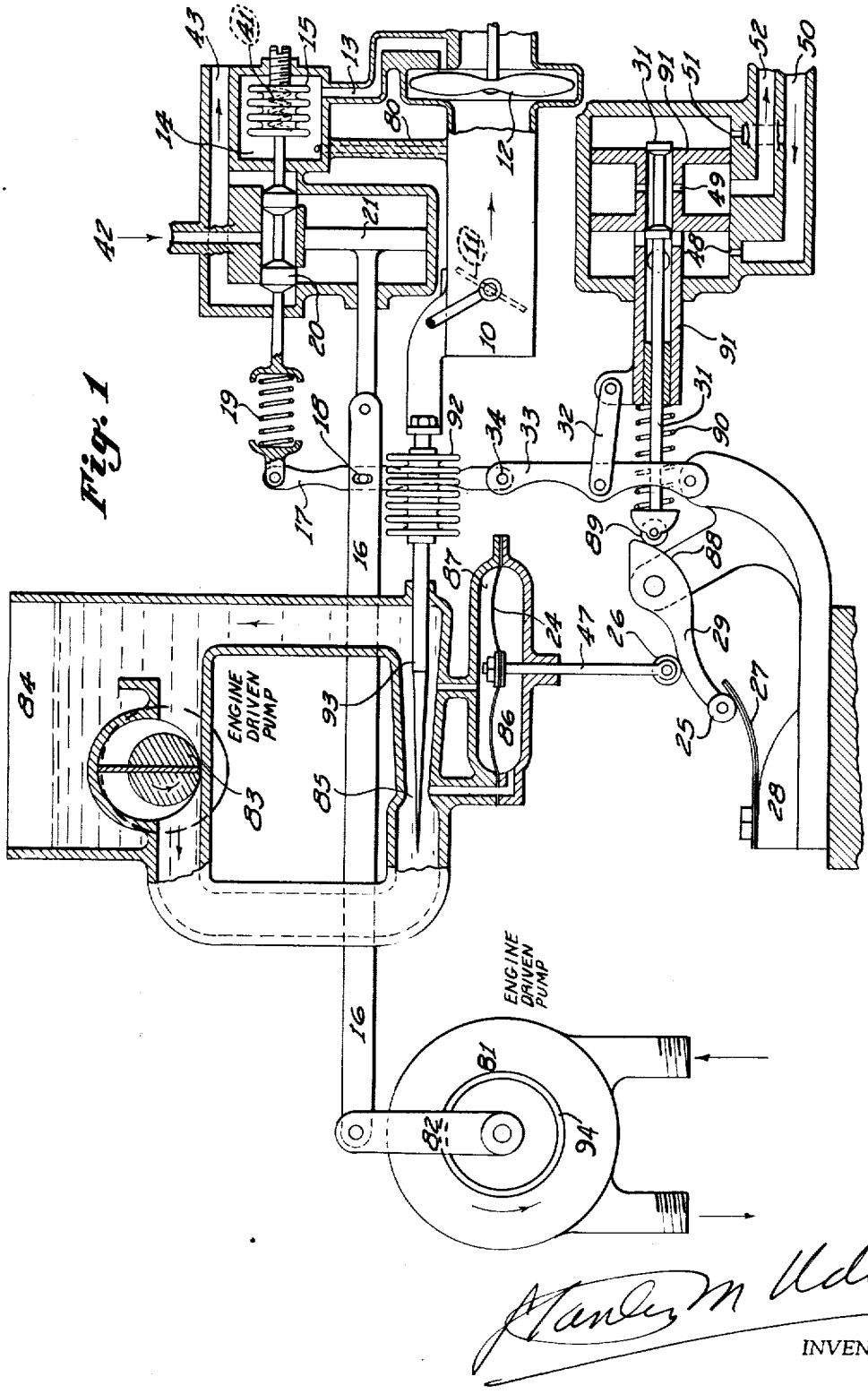
Jan. 16, 1945. S. M. UDALE 2,367,542

MIXTURE CONTROL

Filed Feb. 19, 1943 2 Sheets-Sheet 1

Fig. 1



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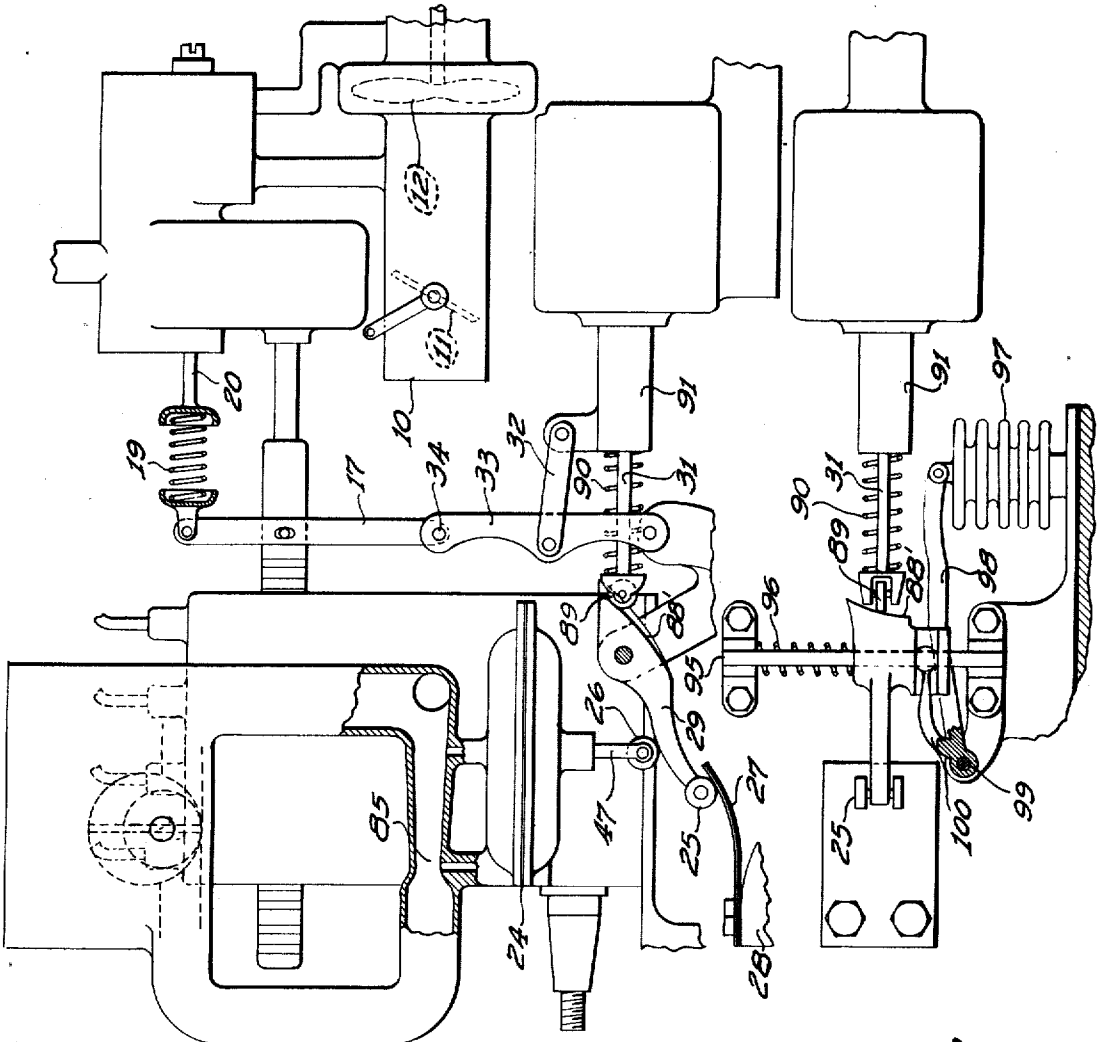


Fig. 2

Fig. 3

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2,367,542

MIXTURE CONTROL

Stanley M. Udale, Detroit, Mich., assignor to George M. Holley and Earl Holley

Application February 19, 1943, Serial No. 476,433

1 Claim. (Cl. 123—119)

The object of this invention is to control the mixture ratio of an internal combustion engine in proportion to the density of the air supply to the engine and to vary the mixture ratio with the speed of the engine and also with the altitude. The three factors which determine the amount of fuel required by an engine are:

(a) R. P. M.

(b) Altitude

(c) The density of the air supplied by the supercharger

In the drawings:

Fig. 1 shows the preferred form of my construction in which the fuel is supplied by a fuel pump to the air entrance of the carburetor commonly known as an injection carburetor.

Fig. 2 shows the fuel being supplied through a plurality of pipes to each cylinder commonly known as fuel injection.

Fig. 3 is a partial plan view of Fig. 2.

In Fig. 1, 10 is the air entrance; 11 is the throttle controlling the admission of air to a supercharger 12. The passage 13 communicates with the chamber 14 in which is located the evacuated bellows 15 which is supported internally by a spring 41. The valve 20 is supported by the evacuated bellows 15 and engages with a compression spring 19, which is pivotally supported on the left by a lever 17. The lever 17 has a movable point of support 34 and engages through a pin 18 with the control rod 16, which controls the control lever 82 of a variable discharge fuel pump 81 driven by the engine. The pump 81 is driven from the engine by a pulley 94. When the lever 82 moves anticlockwise, the fuel discharge increases so that every position of the rod 16 corresponds to a definite number of cc.'s of fuel discharged per revolution of the engine. Hence, the movement of the rod 16 controls the mixture ratio. The rod 16 is connected to the servo-motor piston 21, the movement of which is controlled by the valve 20. The operating force is provided by means of oil under pressure admitted through the passage 42 and escaping through the passage 43.

In order to subject the capsule 15 to the temperature of the supercharged air circulation of air in the chamber 14 is maintained by means of a return passage 80 which is provided but this passage is restricted so that the pressure in the chamber 14 corresponds to the supercharger pressure.

An engine driven pump 83 circulates oil from a tank 84 through a venturi 85. The flow through this venturi 85 therefore varies with the R. P. M. of the engine. The throat of the venturi 85 communicates with the chamber 86 which is located below a diaphragm 24. The chamber 87 communicates with the outlet from the venturi. Hence, the diaphragm 24 is subjected to the drop in pressure in the throat 85 and thus responds to the velocity of flow through the venturi 85 that is to the R. P. M. of the engine. The diaphragm 24 is connected with the rod 47 which carries a roller 26 which engages with the curved side of the lever 29 which carries another roller 25 which in its turn engages with the spring 27 mounted on a support 28. The lever 29 carries a cam surface 88 which engages with the roller 89 which is supported by a rod and valve 31. The roller 89 is held against the cam surface 88 by the compression spring 90. Hence, as the velocity of the engine varies, the valve 31 is moved to the left and right, depending on the changes in the R. P. M. of the engine, because whenever the valve 31 moves away from the neutral position in which it is shown, hydraulic pressure operates on the piston 91 to restore the piston to the position relative to the valve 31 shown in which the pressures on both sides of the piston 91 are equal. Hence, the piston automatically follows the valve 31, this being one of the better-known servomotor mechanisms in general use during the last half century. The piston 91 is compelled to follow the movement of valve 31. Oil is admitted under pressure through the pipe 50 through a restricted opening 48 to the left hand side of the piston 91. Oil may also be admitted to the right hand side of the piston 91 through the restriction 51 from the pipe 51. The opening 49 in the center of the piston communicates at all times with the outlet 52. Hence when the valve 31 moves to the left, oil flows to the left along the passage 50 past the valve 31 through the opening 49 out through the outlet pipe 52.

The pressure on the left of the piston 91 then falls. The pressure on the right hand side of the piston 91 remains at its maximum figure as it is in communication with the oil under pressure. Hence, the piston 91 follows the valve 31 whenever the valve 31 moves away from the position shown in the drawings. This is a very well known servo-motor mechanism and enables the relative feeble forces induced by the flow of liquid through the venturi 85 to be translated into powerful forces which cause the piston 91 to move right and left overcoming friction and carrying with it the link 32 and the lever 33 which carries the supporting pivot 34. Hence,

the mixture ratio is varied with the R. P. M. of the engine, which, with an aircraft engine, is essential. It is well known that when delivering maximum take-off power, these engines are prevented from burning up by being given 50 to 100% excess fuel above the fuel needed for cruising lean. This excess fuel keeps the engine cool. It is also well known that the desired mixture ratio of an engine varies with the altitude. The higher the altitude the richer is the mixture that the engine requires when cruising lean. Further the same airflow in lbs. per hour when cruising lean at sea level will fly the plane with the throttle wide open at altitude. Under the latter circumstances, power rather than economy rules. The aneriod bellows **92** carries the needle valve **93** which varies the throat of the venturi **85** so that at high altitude the effect of the R. P. M. of the engine to enrich the mixture occurs with the lower R. P. M.

By suitably tapering the needle **93** a desired characteristic of the engine may be obtained at any altitude. Hence, if a pattern of mixture ratios is determined for every altitude at varying R. P. M. then this pattern can be duplicated or at any rate approximated in the air. An airplane engine requires an empirical solution. A theoretical solution of a definite fuel air ratio for every air flow will not give the engine what the engine needs. When cruising lean at low altitudes the most economical mixtures are required; much richer mixtures are required at extreme altitudes when the last ounce of power is demanded from the engine.

In Fig. 2 and Fig. 3, as before **10** is the air entrance controlled by a throttle **11**. **12** is the supercharger which supplies air under pressure to the engine. The servo-motor details shown in Fig. 1 are not repeated, being shown in outline. As before, **19** is the spring which controls the valve **20**. The spring as before engages with the upper end of the lever **17** which pivots on the upper end of the lever **33** being pivoted at **34**. As before the link **32** connects the lever **33** with the piston **91**. As before, the roller **89** connected to the valve **31** is pushed to the left by the spring **90** so that the roller **89** engages with the cam surface **88** of the lever **29** which lever, as before, engages through a roller **25** with a spring **27** mounted on a support **28**.

In Fig. 3 the cam surface is slid on the shaft **95** compressing the spring **96**. The movement of this cam **88** is under the influence of the aneroid bellows **97** which engages with the lever **98** which is pivoted at **99**. An arm **100** connected to the arm **98** engages with a cam **88** so that at high altitude when the aneroid bellows **97** expands, the cam surface **88** moves and carries with it the roller **25** so that the position of the roller **89** is dependent on the altitude. As before, there is a venturi **85** the flow through which varies with the speed of the engine, and as before, there is a diaphragm **24** which engages with a rod **47** which in its turn engages with the roller **26**. The lateral movement of the cam surface **88** performs the function of the needle valve **93**, Fig. 1 and the cam surface **88** can be contoured to give a much closer approximation to the desired pattern of fuel air mixture ratios than can the tapered needle. The tapered needle **93** is much simpler but less accurate than the cam surface **88** which is more difficult to make.

The pump **81** which is shown as driven by the engine driven pulley **103** and connecting belt **102** is thus driven at a speed proportional to engine speed. The amount of fuel which the pump **81** is designed to deliver is controlled by the lever **82**.

What I claim is:

A fuel control unit for an internal combustion engine having a supercharger and an engine driven pump adapted to supply a definite quantity of fuel for each revolution of the engine, control means for said pump comprising servo-motor means responsive to the pressure of the air supplied by said supercharger adapted to vary the fuel supply for every change in pressure and additional servo-motor means responsive to the R. P. M. of the engine and to the altitude for varying the quantity of fuel delivered by said pump for every change in speed and in altitude.

STANLEY M. UDALE.

DISCLAIMER

2,367,542.—*Stanley M. Udale*, Detroit, Mich. MIXTURE CONTROL. Patent dated Jan. 16, 1945. Disclaimer filed Mar. 5, 1946, by the inventor and the assignees, *George M. Holley* and *Earl Holley*.

Hereby disclaim claim 1 of said patent.

(*Official Gazette April 9, 1946.*)

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What I claim is:

A fuel control unit for an internal combustion engine having a supercharger and an engine driven pump adapted to supply a definite quantity of fuel for each revolution of the engine, control means for said pump comprising servo-motor means responsive to the pressure of the air supplied by said supercharger adapted to vary the fuel supply for every change in pressure and additional servo-motor means responsive to the R. P. M. of the engine and to the altitude for varying the quantity of fuel delivered by said pump for every change in speed and in altitude.

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