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CONTROL DEVICE FOR THE FUEL FEED OF INTERNAL COMBUSTION ENGINES

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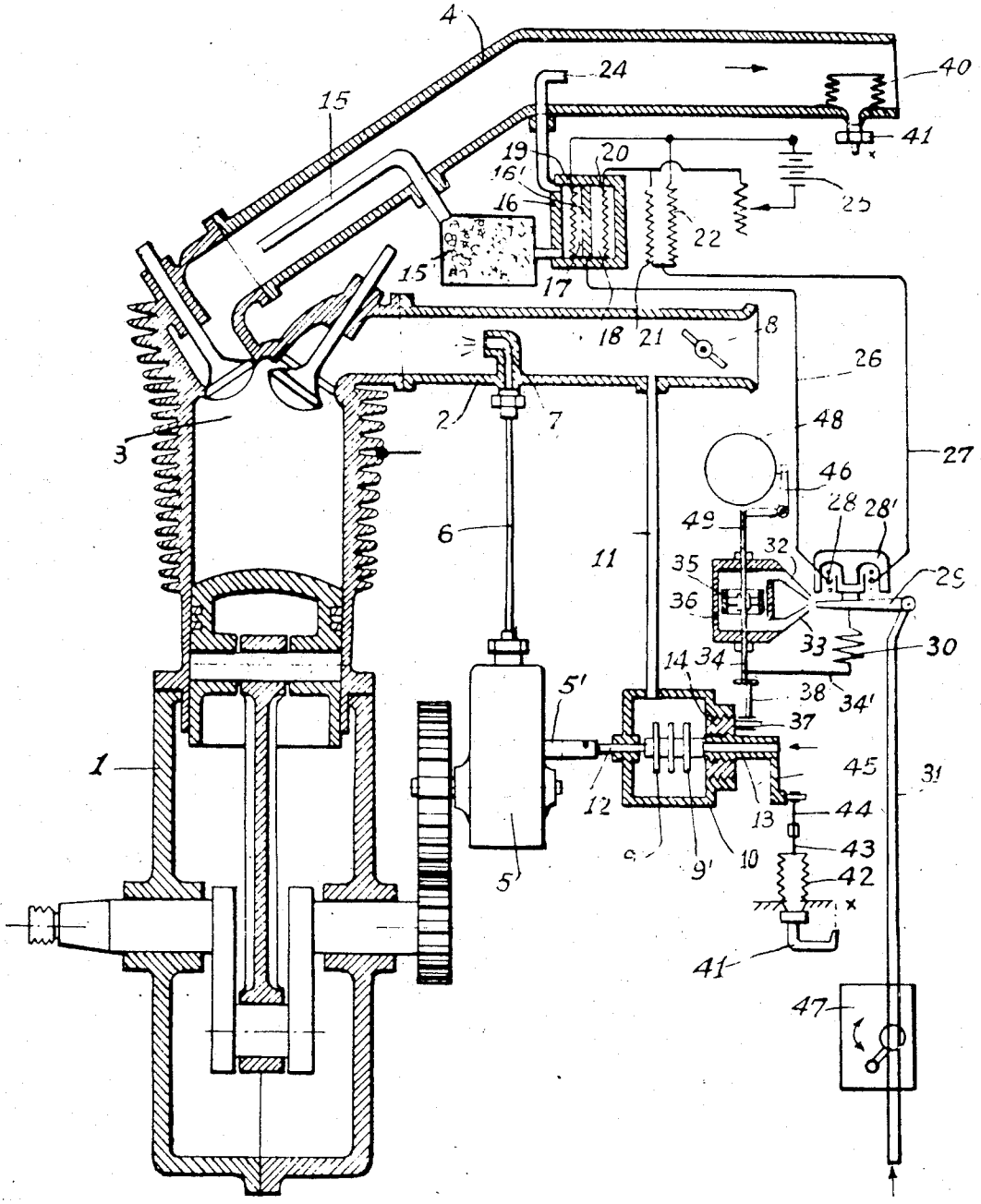

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CONTROL DEVICE FOR THE FUEL FEED OF INTERNAL COMBUSTION ENGINES

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4 Claims. (Cl. 123—140)

This invention relates to improvements in or relating to apparatus for controlling the fuel supply to internal combustion engines, especially for aircraft engines.

As is well known, the fuel supply may be controlled in response to several variables, as for instance the density or pressure of the air in the induction pipe of the engine, or the pressure of the atmosphere, i. e. in the event of aircraft the altitude. Ignoring barometric changes, the atmospheric pressure is always a function of the altitude.

The primary object of the invention is to provide controlling means operating in response to the composition of the exhaust gases in such a manner that in the gas mixture the proportion of fuel to air cannot be weakened below a predetermined limit at which the engine starts to knock. By means of such an automatically controlling apparatus the engine is protected in this way against damages caused by overheating and knocking.

Other aims, objects and advantages of the present invention will be readily understood from the following description with reference to the drawing schematically illustrating one embodiment of the invention.

Referring now to the drawing, 1 is an internal combustion engine comprising a cylinder 3 and a piston reciprocating therein, so as to rotate in a well known manner the crank-shaft of the engine. Two valves are provided for controlling the inlet and the exhaust respectively. In the induction pipe 2 a throttle valve 8 is arranged for controlling the air sucked in by the motor. 7 is an injection nozzle adapted to inject the fuel into the air flow, said nozzle communicating by means of a pipe 6 with a fuel pump 5 of any convenient type driven from the crank shaft of the engine as shown in the drawing. The effective stroke of the pump 5 may be varied in a well known manner by means of an adjusting member 5' so as to vary the amount of fuel injected into the air flow. According to the present invention, said adjusting member 5' will be automatically controlled in accordance with any variable, as for instance the density or pressure of the air in the induction pipe 2. Furthermore, a controlling device responsive to the composition of the exhaust gases will be superposed on said primary controlling device as will now be more fully explained.

In a casing 10 a capsule system is mounted comprising a plurality of individual capsules 9, 9'. The casing 10 communicates by means of a conduit 11 with the induction pipe 2 so that any change in the air density or pressure in the pipe 2 results in an extension or contraction of the capsule system, thereby displacing a pin 12 and the above-mentioned adjusting member 5' of the fuel pump 5 as shown and more fully explained in detail in my copending patent application Ser. No. 156,571 of July 30, 1937.

The capsule system is mounted in such a manner that it may be displaced in axial direction so as to act only as a transmitting member to transmit any additional controlling movement to the pin 12 and the adjusting member 5', as is likewise more fully explained in said above-mentioned patent application. In the embodiment shown a screw-threaded ring 14 is threaded in the casing 10, to said ring a pin 37 is fastened which is linked to a link 38 which is connected to a piston rod 34 of a servo-motor piston 35 driven by a pressure fluid, e. g. oil. The flow of the pressure fluid to the servo-motor will be controlled by means of the well known "Askania" jet pipe relay 29, the jet pipe of which is supplied with the pressure fluid through a pipe 31 connected to any convenient pressure source. The pressure fluid jet flowing out of the jet pipe 29 is variably admitted in accordance with the controlling device acting upon the jet pipe to two channels 32, 33 leading to both sides of the servo-motor 36 respectively. In the neutral or middle position of the jet pipe, as shown in the drawing, the pressure in the channel 32 is equal to that in the channel 33. As soon as the jet pipe is deflected in the manner to be described later on from said neutral position in the one or the other direction, the servo-motor piston 35 will be correspondingly displaced, thereby rotating by means of the pin 37 the screw-threaded ring 14, thus displacing the adjusting member 5' of the fuel pump 5 through the transmitting capsule member and pin 12.

The controlling means acting upon the jet pipe 29 is responsive to the variation in the composition of the exhaust gases in the following manner.

The means responsive to the variation in composition of the exhaust gases comprise a casing 16 divided by a wall 16' into two chambers 17, 18, each chamber being provided with a resistance wire 19, 20, respectively. The chamber 17 communicates with the exhaust pipe 4 of the engine by means of a pipe 15, a filter 15' of any convenient type being inserted in said pipe. In this way a part of the exhaust gases flows through the pipe 15 into the chamber 17 and

out of this chamber back to the exhaust pipe 4 by means of a pipe 24. The second chamber 18 contains a suitable comparison gas, e. g. air. The resistance wires 19, 20, as mentioned above are each arranged as a branch of a Wheatstone bridge. The two other branches thereof are shown as at 21, 22. The branches of this Wheatstone bridge will be heated to a predetermined degree by means of any source of current as at 25. As shown in the drawing, two lines 26, 27, respectively, lead from the Wheatstone bridge to a solenoid 28, the armature of which is operatively connected to the jet pipe 29.

The device described operates as follows:

The current source 25 heats the resistance wires 19, 20 to a predetermined degree. The temperature of the wires 19, 20 remains constant, unless the composition of the exhaust gases changes. Any change in the composition results in a change of temperature of the resistance wire 19 due to the fact that any change in composition causes a change in thermal conductivity of the exhaust gases. A device responsive to the composition of the exhaust gases is well known per se as for instance shown and described in U. S. Patent No. 2,040,778, issued May 12, 1936. If for instance the proportion of hydrogen in the exhaust gases increases, then the thermal conductivity of the exhaust gases likewise increases so that the temperature of the resistance wire 19 decreases, in consequence thereof the equilibrium of the Wheatstone bridge will be disturbed so that a current will flow through the lines 26, 27, thereby exciting the solenoid 28 and changing the position of the jet pipe 29 with reference to the entrance openings of the channels 32, 33. Accordingly in this way the jet pipe 29 follows the changes in the composition of the exhaust gases.

In order to have a predetermined position of the jet pipe 29 at a predetermined composition of the exhaust gases a well known restoring system is provided including an arm 34' fastened to the rod 34 of the servo-motor piston 35 and a spring 30 arranged between said arm 34' and the jet pipe 29 so as to exert on the jet pipe a restoring force in opposition to the controlling force of the solenoid.

As shown in the drawing, the servo-motor piston 35 does not only control the effective stroke of the fuel pump 5, but also the timing of ignition. For this purpose the rod 49 of the piston 35 is operatively connected to a distributor 48 by means of a link 46, said rod 49 being provided for adjusting the setting of the distributor 48 of the ignition apparatus in the well known manner.

The capsule system 9 mentioned above controls the fuel supply to the motor in accordance with the density or pressure of the air in the induction pipe 2. This primary controlling system will be so adjusted that the proportion between fuel and air remains at its optimum or at any desired point for achieving—as far as possible—an economical working. Should this primary controlling system for any reason tend to decrease the amount of fuel below said proportion in accordance with the density or pressure of the air in the induction pipe 2, the secondary controlling means operating in response to the composition of the exhaust gases becomes effective in such manner that the proportion remains above said proportion.

In the event it is desirable, for instance in emergency cases when the plane is falling or to keep the motor going without fuel economy or to obtain a richer mixture, to pass said proportion the pilot may interrupt the flow of pressure fluid through the conduit 31 to the jet pipe 29 so as to render ineffective the secondary controlling means. In the conduit 31 a valve is provided as diagrammatically shown at 47. The flow of fluid through conduit 31 is cut off by operating valve 47 whereby the relay becomes inoperative but the piston 35 may then be moved manually by the arm 34' for instance and it will remain in such position by friction or it may be suitably locked in any set position. This will eliminate the effect of the exhaust gas analyzer.

Besides the capsule system 9 any other primary control device may be used for controlling the fuel supply. In the embodiment shown in the drawing the adjusting member 5' of the fuel pump 5 will be also controlled in dependence on the temperature of the exhaust gases. This temperature responsive means comprises a casing 40 arranged in the exhaust pipe 4, said casing contains any suitable liquid, the vapor pressure of which is responsive to the temperature. Accordingly a bellows 42 communicates with the casing 40 by means of a conduit 41 so that the bellows will be extended or compressed in response to the temperatures of the exhaust gases, thereby actuating the rod 43, a link 44 and an arm 45 attached to the screw-threaded capsule supporting member 13. Any rotation of the member 13 results in an axial displacement of the capsule system 9 and an adjustment of the fuel pump controlling member 5'.

It is to be noted that the embodiment shown may be modified without departing from the spirit of my invention as defined in the appended claims.

What is claimed is:

1. The combination in an internal combustion engine having an air throttle valve in the air intake manifold, of fuel quantity control means regulated by a device responsive to the pressure in the intake manifold on the engine side of the air throttle valve, and means for adjusting the pressure responsive device so as to modify its effect on the fuel control means, said adjusting means being responsive to variations in the composition of the exhaust gases.

2. The combination in an internal combustion engine having an air throttle valve in the air intake manifold, of fuel quantity control means regulated by a device responsive to the pressure in the intake manifold on the engine side of the air throttle valve, and a jet pipe relay and servo-motor of which the latter is connected to the pressure-responsive device for adjusting the latter so as to modify its effect on the fuel control means, said jet pipe relay being responsive to variations in the composition of the exhaust gases.

3. The combination in an internal combustion engine having an air throttle valve in the air intake manifold, of fuel quantity control means regulated by a device responsive to the pressure in the intake manifold on the engine side of the air throttle valve, a jet pipe relay and servo-motor of which the latter is connected to the pressure responsive device for adjusting the latter so as to modify its effect on the fuel control means, said jet pipe relay being responsive to variations in the composition of the exhaust gases, and emergency control means for rendering said jet pipe relay and servo-motor ineffective on said pressure responsive device.

4. The combination in an internal combustion engine having an air throttle valve in the air intake manifold, of fuel quantity control means regulated by a device responsive to the pressure in the intake manifold on the engine side of the air throttle valve, a jet pipe relay and servo-motor of which the latter is connected to the pressure responsive device for adjusting the latter so as to modify its effect on the fuel control means, said jet pipe relay being responsive to variations in the composition of the exhaust gases, and ignition adjusting means operatively connected to the servo-motor to adjust the ignition timing in dependence on the composition of the exhaust gases.

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