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DEVICE FOR AUTOMATICALLY REGULATING THE AMOUNT OF FUEL INJECTION

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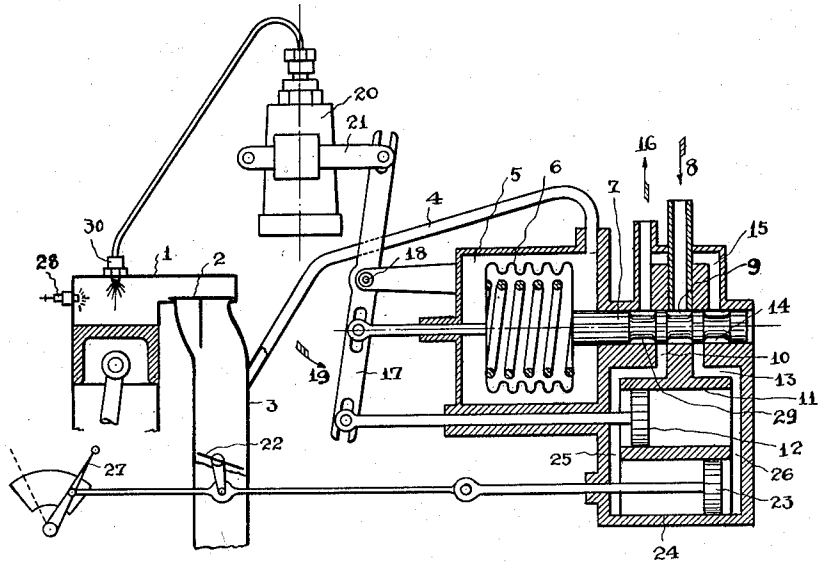

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DEVICE FOR AUTOMATICALLY REGULATING THE AMOUNT OF FUEL INJECTION

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1 Claim. (Cl. 123—139)

This invention relates to a device for automatically regulating the fuel supply from the fuel injection pump responsive to variation of the pressure in the air suction pipe of an internal combustion engine.

In an internal combustion engine of the type in which volatile fuel such as gasoline is injected into the engine cylinder or into the suction pipe and is ignited by an electric spark, it is old to provide a bellows functioning responsive to the pressure in the suction pipe, and a servo-piston controlled by said bellows for actuating a fuel injection regulating mechanism. In such device, when the air throttle valve of the engine is suddenly opened to rapidly increase the number of revolutions of the engine, the action of said servo-piston is retarded for a certain length of time from the movement of said throttle valve, so that the relative amount of fuel injection to the amount of air becomes smaller, resulting in incomplete combustion of the fuel mixture and failing to attain a smooth acceleration of the engine. The invention has for its object to remove such disadvantage, and is characterized by the provision of another pressure oil cylinder having an accelerating piston connected to the air throttle valve, the oil inlet and outlet passages of said cylinder being connected to the ends of the servo-piston cylinder, so that the servo-piston is moved as soon as the air throttle valve is opened for acceleration, whereby rapidly increasing the amount of fuel injection and preventing thereby too small fuel-air ratio.

The accompanying drawing shows one form of the device according to this invention by way of example.

Referring to the drawing, 1 designates an engine cylinder, and 2 a suction valve. 28 is an ignition plug, and 30 is a fuel injection valve. 3 is a suction pipe, and the pressure in said suction pipe is led through a conduit 4 into a chamber 5. In said chamber 5 is provided a bellows 6 which is maintained nearly at vacuum. When the pressure in the suction pipe 3 increases, said bellows 6 is contracted, and a pressure-oil distributing valve 7 connected to said bellows is thereby shifted leftwards, permitting the pressure-oil introduced in the direction of arrow 8 to pass through a space 9 in the distributing valve and an oil conduit 10 into the space left hand side of a servo-piston 12 in a pressure-oil cylinder 11, whereby said servo-piston is moved rightwards. The oil in the space righthand of the servo-piston 12 is discharged through an oil conduit 13, a space 14 in the distributing valve and an oil conduit 15 in the direction of arrow 16. Upon the rightward movement of the servo-piston 12, a lever 17 is oscillated about a pivot 18 in the direction of arrow 19, thereby shifting to the left a fuel supply regulating rod 21 of a fuel injection pump 20 for increasing the amount of fuel injection, at the same time shifting the pressure-oil distributing valve 7 rightwards, so that the oil conduits 10 and 13 are closed, and the servo-piston 12 is stopped. When the pressure in the suction pipe decreases, the bellows 6 expands, moving the pressure-oil distributing valve 7 and the servo-piston 12 in the reverse direction, so that the fuel supply regulating rod 21 is moved to the right, thereby decreasing the amount of fuel injection. Thus, it will be seen that the pressure-oil distributing valve 7 always tends to lie in the position to close the oil conduits 10 and 13, so that the fuel supply is regulated according to the expansion and contraction of the bellows 6. The above described mechanism for regulating the amount of fuel injection is known.

With such mechanism per se, when the air throttle valve 22 is rapidly opened and the amount of air sucked into the engine cylinder is increased by sudden increase of the pressure in the suction pipe, the increase of fuel supply can not instantly follow such increase of the amount of air, because the mechanism is of such nature that there is a retardation in the responsive increase of the pressure in the chamber 5, movement of the pressure-oil distributing valve 7, and the flow of the pressure-oil into the servo-piston cylinder 11, so that the fuel-air ratio is lowered and it becomes difficult to effect the desired smooth acceleration of the engine.

Now, according to this invention, there is provided another pressure-oil cylinder 24 having therein an accelerating piston 23 which is connected to the air throttle valve 22. Said cylinder 24 is in communication with the main servo-piston cylinder 11 through oil passages 25 and 26. When a lever 27 is pulled to the left to suddenly open the air throttle valve 22, the accelerating piston 23 is thereby shifted to the left suddenly, so that the oil in the left hand space of the cylinder 24 will flow into the servo-piston cylinder 11 through the passage 25, thereby rapidly moving the servo-piston 12 rightwards. The oil in the space right to the servo-piston flows through the passage 26 to the righthand side of the accelerating piston 23. Thus, the fuel supply is rapidly increased by the leftward movement of the fuel

supply regulating rod 21 actuated by the rightward movement of the servo-piston 12, without necessitating the flow of the pressure-oil from the oil conduit 10. In this case, the pressure-oil distributing valve 7 is also moved rightwards by means of the lever 17, so that the pressure-oil will tend to flow through the conduit 13 into the righthand space of the servo-piston cylinder 11 and also to the righthand side of the piston 23 through the passage 26 and, at the same time, a portion of the oil in the lefthand space of the servo-piston cylinder flows out through the conduit 10 and the space 29 in the distributing valve 7 in the direction of arrow 16. The amount of said oil flowing in and out through the distributing valve is made small comparatively to the amount of the oil flowing through the passages 26 and 25 by the movement of the accelerating piston 23, so that the servo-piston 12 is moved to the right during the movement of the accelerating piston 23. Shortly after the movement of the accelerating piston 23, the bellows 6 is contracted by increase of the pressure in the chamber 5, and the pressure-oil distributing valve 7 is moved to the left, closing the oil conduits 10 and 13, so that the servo-piston is stopped. When the throttle valve 22 is suddenly closed, the reverse movements of the parts will occur, so that the amount of fuel injection is rapidly decreased, preventing too great fuel-air ratio. When the air throttle valve 22 is slowly and gradually opened or closed, the accelerating piston 23 is also moved slowly. Therefore, the amount of the oil flowing through the passages 25 and 26 by the movement of the accelerating piston 23 is smaller than the amount of the oil flowing into or out of the servo-piston cylinder 11 through the oil conduits 10 and 13, so that a minor influence will be given to the movement of the servo-piston 12 from the accelerating piston 23. In this case, an ample time is given for the action of the bellows 6, the pressure-oil distributing valve 7 and the servo-piston 12 responsive to variation of the pressure in the suction pipe 3, so that the help of the accelerating piston 23 is scarcely required.

It will be obvious that when the air throttle valve is stopped the servo-piston 12 functions just as when there is not provided the accelerating piston. Thus, the accelerating piston 23 will function suitably according to its characteristics responsive to the actuating speed of the air throttle valve 22, whereby serving to always maintain the adequate fuel-air ratio under varying operating conditions.

From the foregoing, it will be seen that the present invention relates to a mechanism for automatically regulating the fuel supply employing the bellows, pressure-oil distributing valve and servo-piston, and is characterized by this that another cylinder having an accelerating piston connected to the air throttle valve is provided, the oil inlet and outlet passages of said cylinder being connected to the ends of the servo-piston cylinder, so that the fuel injection is rapidly increased according to the rate of acceleration of the engine, thereby attaining smooth acceleration.

What I claim is:—

A device for automatically regulating the fuel supply comprising a bellows adapted to expand or contract responsive to the pressure of the air to be sucked into the engine cylinder, a distributing valve connected to said bellows for distributing oil under pressure, fuel injection means provided with regulating mechanism, a servo-motor including a cylinder and a piston controlled by said distributing valve for actuating the fuel injection regulating mechanism, and an accelerating device connected with the servo-motor piston comprising an auxiliary cylinder, an accelerating piston connected to the air throttle valve of the engine, oil inlet and outlet passages for said auxiliary cylinder connected to the opposite ends of said servo-motor cylinder, so that when said throttle valve is rapidly opened to rapidly accelerate the engine said servo-motor piston is rapidly moved by the rapid movement of said accelerating piston, regardless of the position of said bellows and the pressure-oil distributing valve, thereby increasing rapidly the amount of fuel injection responsive to increase of the amount of the air.

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