

[54] **FUEL FEED CONTROL DEVICE FOR
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123/139 BD, 123/139 E[56] **References Cited****UNITED STATES PATENTS**

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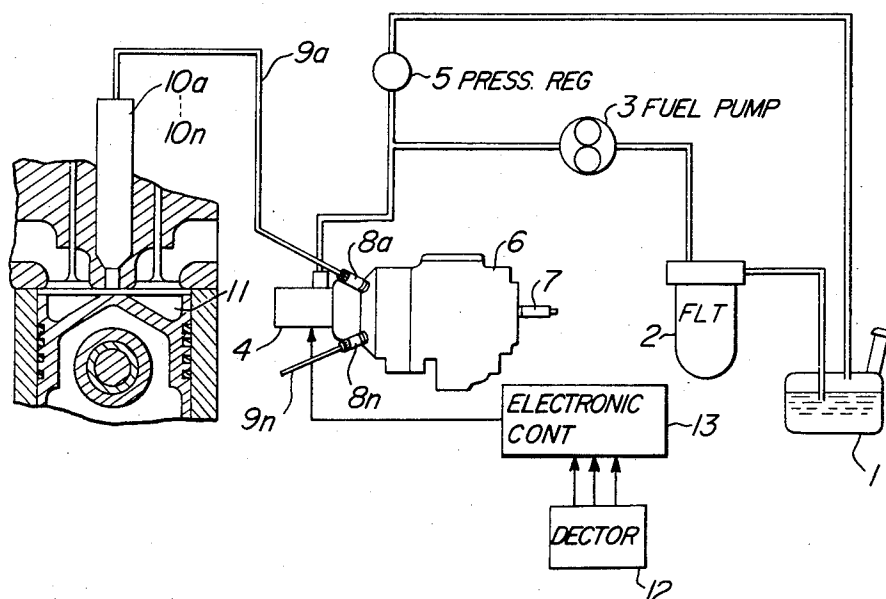
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[57] **ABSTRACT**

A fuel feed control device for internal combustion engines, having a fuel supply source for supplying fuel at an optional predetermined pressure and a fuel injection pump for feeding the pressurized fuel to fuel injection valves mounted in an engine, and further having a valve disposed directly in the pump chamber of said pump in communication with said fuel supply source and opened and closed by electric signals, the quantity of fuel discharged from said fuel injection pump and the period of discharge being regulated by controlling the current conducting time and current conducting period to said valve.

1 Claim, 2 Drawing Figures

FUEL FEED CONTROL DEVICE FOR INTERNAL COMBUSTION ENGINES

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to a device for feeding and injecting fuel into each cylinder of internal combustion engines, particularly compression ignition internal combustion engines.

2. Description of the Prior Art

As a device for feeding and injecting fuel into each cylinder of compression ignition internal combustion engines, there has generally been used an in-line type pump having the same number of reciprocating pump units as the number of the cylinders of an engine arranged side by side each for each cylinder, or a distribution type pump having one rotatable and reciprocable plunger by which fuel is fed with pressure and distributed to the respective cylinders of an engine at desired times.

In such prior art devices, however, the quantity of fuel required by the engine is controlled by a combination of mechanical elements, such as a centrifugal governor utilizing centrifugal force, a throttle valve, etc., and the fuel injection time is controlled by mechanically deviating the phases of the crank shaft of the engine and the pump driving shaft. Therefore, these devices have the problem that the mechanical construction thereof inevitably undergoes various restrictions and the demand of the engine cannot be fully satisfied.

SUMMARY OF THE INVENTION

The object of the present invention is to provide a fuel feed control device in which feeding of fuel is controlled by mechanical means which undergoes less mechanical restrictions and fuel is fed directly into the pump chamber of a fuel feed pump, whereby the device can meet the demand of the engine more freely and accurately than the prior art devices.

According to the present invention there is provided a fuel feed control device for internal combustion engines, which has a fuel supply source for supplying fuel at an optional predetermined pressure and a fuel injection pump for feeding the pressurized fuel to fuel injection valves mounted in an engine, and further having a valve disposed directly in the pump chamber of said pump in communication with said fuel supply source and opened and closed by electric signals, the quantity of fuel discharged from said fuel injection pump and the period of discharge being regulated by controlling the current conducting time and current conducting period to said valve.

In the prior art devices, the quantity of fuel fed to the engine and the period of fuel injection are regulated by mechanical means, such as a centrifugal weight and a link mechanism, and therefore, the regulating operation is subjected to various restrictions. However, according to the present invention the fuel feed controlling operation is effected entirely by electronical means, so that there can be obtained a great advantage that the feeding of fuel can be controlled with an accuracy sufficient to meet the demand of the engine. Furthermore, since according to the invention the valve which is opened and closed by electrical means is provided directly in the pump chamber of the fuel in-

jection pump, there can also be obtained such practical advantage that an accurate fuel metering and every excellent response characteristic of fuel feeding operation can be obtained and the current conducting period to the valve can be set to be sufficiently long.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a diagrammatic illustration showing the entire fuel feed control device according to the invention, and

FIG. 2 is a cross-sectional view showing the details of the essential portion of the fuel feed control device.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The present invention will be described hereinafter with reference to an embodiment comprising a distribution type pump. In FIG. 1, reference numeral 1 designates a fuel tank, and fuel oil in said tank 1 is fed to an electromagnetic valve 4 through a filter 2 by a fuel pump 3. In this case, the pressure of the fuel oil supplied to the electromagnetic valve 4 is maintained at an optional predetermined value by a pressure regulator 5. Reference numeral 6 designates a main body of a distribution type fuel injection pump, and 7 designates a driving shaft thereof, which is driven from an engine not shown. The fuel injection pump delivers the fuel oil to discharge valves 8a-8n at suitable times, during one revolution of the driving shaft 7. The fuel oil from the respective discharge valves is introduced into fuel injection valves 10a-10n through pressure pipes 9a-9n and injected into the combustion chambers of an engine from said respective fuel injection valves. Reference numeral 12 designates a detector to detect the position of an accelerator pedal, the temperatures at various portions, the rate of rotation of the engine, etc., and 13 designates an electronic controller for setting the time and duration of current conducted to the electromagnetic valve 4, which controls the quantity of fuel oil to be fed by the current conducting period to the electromagnetic valve 4 and the fuel oil injection time by the current conducting time to said electromagnetic valve, in response to various electric signals.

Turning now to FIG. 2, reference numeral 14 designates a plunger of the distribution type fuel injection pump which makes a predetermined reciprocal motion while being rotated through the driving shaft 7 and a cam disc not shown, to deliver with pressure the fuel to the respective cylinders, i.e., the respective discharge valves 8a-8n, of the engine in the direction of the arrow a and suck fuel. Reference numerals 15, 16 designate cylinders in which the plunger 14 is slidably received. Reference numeral 4 indicates the electromagnetic valve to which the fuel maintained at the predetermined pressure by the pressure regulator is supplied in the direction of the arrow b. A valve member 4a is located at the head of the cylinder 16 and disposed directly in the pump chamber 17. The fuel is delivered from the fuel injection pump to the respective discharge valves 8a-8n through a discharge port 18 provided in the plunger 14 and discharge ports 19 provided in the cylinder 15, the number of said discharge ports 19 being the same as the number of the cylinders of the engine. Reference numeral 20

designates an overflow port formed through the cylinder 16 to set the end of the fuel injection period, and 21 designates overflow passages formed radially in the plunger 14. The discharge port 18 and the overflow passages 21 of the plunger 14 are communicated with the pump chamber 17 through an axial bore 22.

The fuel feed control device of the invention constructed as described above operates in the following manner: Namely, the fuel sucked from the fuel tank 1 by the fuel pump 3 through the filter 2 is constantly maintained at the predetermined pressure by the pressure regulator 5 and the fuel overflowing said pressure regulator is returned to said fuel tank 1. On the other hand, the opening or closing of the electromagnetic valve 4 is effected by an electric signal from the electronic controller 13 which emits said electric signal upon receiving signals from the detector 12 indicative of the position of the accelerator pedal, the temperatures at various portions, the rate of rotation of the engine, etc., (by which the proper fuel injection time for each cylinder is detected) which are electrically detected by said detector 12. When a current is conducted through the coil 4b of the electromagnetic valve 4 from the electronic controller 13, a movable core 4c is moved in the direction of the arrow *d* by a magnetic drag exerted thereon and depresses the valve member 4a against the biasing force of a spring 4d. The seating portion 4e of the valve member 4a is thus detached from a valve seat 4f and the fuel oil flows into the pump 6 in the direction of the arrow *b*. In this case, since the valve member 4a is disposed directly in the pump chamber 17, the fuel oil entering the pump 6 in the direction of the arrow *b* is directly metered and stored in said pump chamber 17 without going through any other passage. Now, when the current supply to the coil 4b of the electromagnetic valve 4 is interrupted, the seating portion 4e of the valve member 4a closes the valve opening and the plunger 14 is moved upward in the direction of the arrow *c*, whereby a compression stroke sets in. The pressurized fuel oil, when the discharge port 18 in the plunger 14 is brought into communication with the discharge ports 19 in the cylinder 15, is discharged through said discharge ports 18, 19 and the discharge valves 8a - 8n in the direction of the arrow *a*, to flow into the injection valves 10a - 10n through the pressure pipes 9a - 9n, and injected into the combustion chambers 11 of the engine from said respective injection valves 10a - 10n. As the plunger 14 further rises and when the radial overflow passages 21 formed therein are brought into communication with the overflow port 20 in the cylinder 16, the pressurized fuel within the pump chamber 17 flows out of the pump through said overflow passages 21 and said overflow port 20 as indicated by the arrow *e* and thus the end of the fuel injection period can be positively set. The above-described cycle of operation is repeated incident to the rotational and reciprocal motion of the plunger 14. The quantity of fuel discharged from the fuel injection pump, that is, the quantity of fuel to be injected, is determined by the opening period of the valve member 4a which is disposed directly in the pump chamber 17 of the fuel injection pump and operated completely electrically. Therefore, it will be understood that the quantity of fuel can be controlled by the period of conducting the current through the

coil 4b of the valve 4. Namely, by suitably selecting the current conducting period to the coil 4b by the electronic controller 13 upon electrically detecting the various operational conditions of the engine, e.g., the rate of rotation, the load, the temperatures at various portions, etc., of the engine, it is possible to feed an optimum quantity of fuel demanded by the engine. In addition, since the valve member 4a is disposed directly in the pump chamber 17 of the fuel injection pump as stated above, the fuel metered by said valve member 4a can accurately be supplied into the pump chamber 17 with no time delay, on every opening operation of the valve member, and the fuel supply period (the current conducting period to the coil 4b) can be selected within a wide range. As for the fuel injecting time, a proper fuel injecting time as demanded by the engine can be set electrically freely by electrically detecting the above-mentioned various operational conditions of the engine and properly selecting the current conducting time to the coil 4b by the electronic controller 13.

As described above, the fuel feed control device according to the invention has a fuel supply source for supplying fuel at an optional predetermined pressure and a fuel injection pump for feeding the pressurized fuel to fuel injection valves mounted in an engine, and further having a valve disposed directly in the pump chamber of said pump in communication with said fuel supply source and opened and closed by electric signals; and the quantity of fuel discharged from said fuel injection pump and the period of discharge are regulated by controlling the current conducting time and the period of discharge to said valve. Therefore, according to the invention the quantity of fuel fed to the engine and the fuel injection period can be controlled completely electrically, without undergoing various restrictions which have been imposed on the prior art devices due to the use of mechanical means such as a centrifugal weight, a link mechanism, etc., and a fuel feed control sufficient to meet the demand of the engine can be achieved. Further, according to the invention, since the electrically operated valve is disposed directly in the pump chamber of the fuel injection pump, there can be obtained such practical advantage that a highly accurate metering of fuel and excellent response characteristic of the fuel feeding operation can be obtained and the current conducting period to the valve can be set sufficiently long. The present invention can of course be applied, not only to the distribution type pump as described and illustrated herein but also to an in-line type pump, but the application of the invention to the distribution type pump is particularly advantageous in that only one electrically operative valve suffice the purpose irrespective of the number of cylinders of the engine.

We claim:

1. A fuel feed control device for internal combustion engines, comprising:

fuel supply source means for supplying fuel at a predetermined pressure,

fuel injection pump means for feeding the pressurized fuel to fuel injection valves mounted in the engine, and an electromagnetic valve secured to said fuel injection pump and having a valve member provided with a seating portion, a valve seat, a movable core and a coil, and said seating

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portion and said valve seat being engageable in seating relation with each other inside the pump chamber of said fuel injection pump, said valve member being moved to open and close said electromagnetic valve so as to admit and block passage of fuel in response to the movement of said movable core which is moved by electric signals applied

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to said coil, so that the quantity of fuel discharged from said fuel injection pump and the period of the discharge are regulated by controlling the timing and the length of time for conducting current to said coil of said electromagnetic valve.

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