

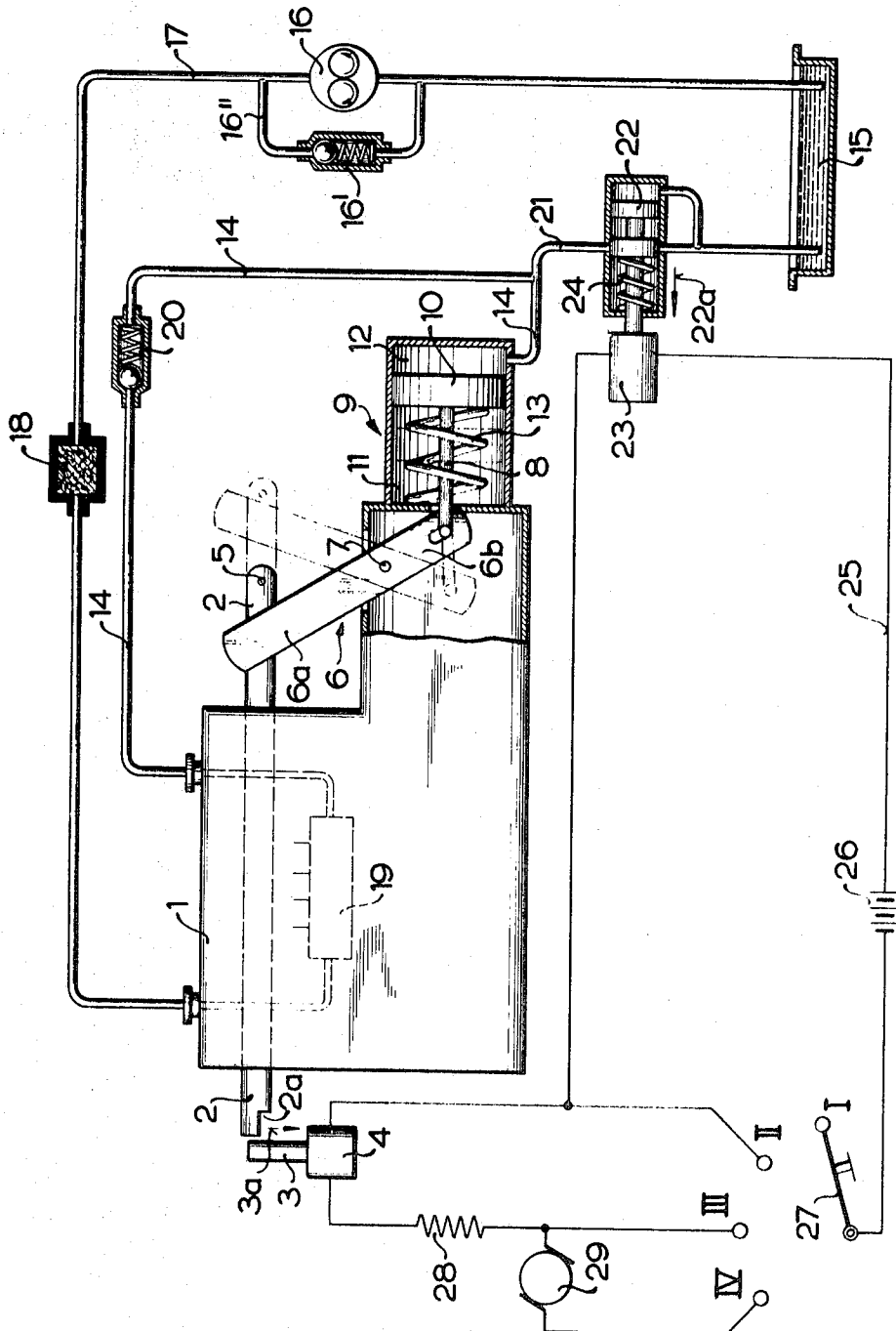
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CONTROL AND ACTUATING SYSTEM FOR DIESEL ENGINES

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CONTROL AND ACTUATING SYSTEM FOR DIESEL ENGINES

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7 Claims

ABSTRACT OF THE DISCLOSURE

A control and actuating system for operating an internal combustion engine, including a hydraulic servo system which, when energized by virtue of the de-energization of a stop magnet, moves the fuel quantity control member of a fuel injection pump into a zero position; a bolt normally limiting the maximum displacement of said control member to a setting for full load fuel delivery, said bolt is associated with a starting magnet which, when energized, moves said bolt to such an extent as to permit said control member to be positioned in a setting in which the fuel injection pump delivers fuel quantities (starting quantity) that are in excess of the full load fuel quantities.

BACKGROUND OF THE INVENTION

This invention relates to a control and actuating system for diesel engines, particularly of the type operating on injected fuel and built into automotive vehicles. The system is of the type that includes an electromagnet which is adapted to set the fuel quantity control member of a fuel injection pump into a zero (shut-off) position.

Known devices of the aforementioned type are disadvantageous because they require a large and expensive electromagnet due to the relatively large forces necessary for shifting the fuel quantity control member of the fuel injection pump and due to the relatively large path of displacement of said member. Such a device is described, for example, in German Pat. No. 1,089,590.

The control and actuating system with which the invention is concerned, is further of the type that has an actuating element which may be successively set to a stop position (position I), a normal position (position II), a prepare-for-starting position (position III), and a starting position (position IV). In position I, the fuel quantity control member of the fuel injection pump is in a zero (no fuel delivery) position; in position II, the fuel quantity control member is displaceable up to and including a setting for full load fuel delivery; in position III, a heating resistance is energized and the fuel quantity control rod may be displaceable into a setting in which the delivered fuel quantities exceed those for full load, and in position IV, an electric starting motor is energized, preferably together with the aforementioned resistance heater, while the fuel quantity control member is permitted to be displaced as in position III.

A device as precedingly outlined is disclosed in German Pat. No. 865,837. It is a disadvantage of known devices of this type that the actuating lever has to be relatively long if the manual force applied thereto is to be held at a small value. Further, the application of such known device is limited because the associated Bowden-cable may not be arbitrarily long.

OBJECT AND SUMMARY OF THE INVENTION

It is a principal object of the invention to provide an improved system of the aforementioned type wherefrom the disadvantages outlined above are eliminated.

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Briefly stated, according to the invention, there is provided a hydraulic servo system which is pressurized when the stop-magnet is in a de-energized condition and unpressurized when said magnet is in an energized condition. When pressurized, the servo system sets the fuel quantity control member of a fuel injection pump into its zero (no fuel) position, and when unpressurized, it permits said fuel quantity control member to be moved into various open positions (settings for different fuel quantities to be delivered by the fuel injection pump).

According to the invention, to effect the aforementioned different operations in positions I-IV, there are provided (a) a preferably key-operated electric switch (constituting the aforementioned actuating element) which energizes a second electromagnet (starting magnet) in position IV, and preferably also in position III and energizes the stop-magnet in positions II, III and IV, and (b) a bolt movable into and partially out of the path of travel of the fuel quantity control member for limiting the maximum setting of the latter to full load fuel delivery or, respectively, for permitting the fuel quantity control member to be moved into a setting in which the fuel quantity delivered by the fuel injection pump exceeds the full load fuel quantity.

It is a further feature of the invention to combine the aforementioned elements (a) and (b), known by themselves, with the said hydraulic servo system to obtain an arrangement which satisfies the requirements for a simple actuation from an arbitrarily remote location and which requires only a small electromagnet.

According to a preferred embodiment of the invention, the hydraulic medium used in the servo system is taken from the fuel circuit of the internal combustion engine.

The invention will be better understood, as well as further objects and advantages will become more apparent, from the ensuing detailed specification of a preferred, although exemplary, embodiment taken in conjunction with the sole figure which is a substantially simplified diagrammatic illustration of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

A fuel injection pump 1 associated with a diesel combustion engine (not shown) comprises a fuel quantity control rod 2 displaceable along its length dimension. Adjacent to one end of the fuel quantity control rod 2, there is disposed a bolt 3 which is urged by return means (not shown) to assume a position in the path of travel of control rod 2, limiting the maximum displacement thereof to a setting in which full load fuel quantities are delivered by the fuel injection pump. This position of bolt 3 is illustrated in the figure. The bolt 3 is coupled with an electromagnet 4 (starting magnet) which, when in an energized condition, moves the bolt 3 in the direction of arrow 3a to such an extent that it allows greater freedom of movement for the fuel quantity control rod 2. Thus, the latter may slide over the terminus of the withdrawn bolt 3 until shoulder 2a of control rod 2 abuts thereagainst. Such a position of the control rod 3 defines a setting in which the fuel quantity delivered (for starting the engine) exceeds the full load fuel quantity.

The terminus of the fuel quantity control member 2 remote from the bolt 3 carries a transversal pin 5 which is engageable by an arm 6a forming part of a lever 6 pivotable about an axis 7. The arm 6b, also forming part of lever 6, is connected with the output rod 8 of a hydraulic cylinder assembly generally indicated at 9. The latter comprises a piston 10 to which rod 8 is secured. The piston 10 is reciprocable in a cylindrical space which is divided thereby into cylinder chambers 11 and 12. In cylinder chamber 11 there is disposed a compression spring 13 which urges the piston 10 and thus the arm 6 into a terminal position shown in solid lines. In this posi-

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tion the fuel quantity control member 2 is not affected by the arm 6a of the lever 6. The cylinder chamber 12 communicates with a hydraulic conduit 14 which is adapted to admit hydraulic fluid under pressure to chamber 12. In the presence and by virtue of such pressurized fluid in chamber 12, the piston 10 is displaced against the force of the spring 13 to such an extent that it assumes, together with lever 6, a position shown in broken lines. In this position the fuel quantity control member 2 is set to its zero or stop position (no fuel delivery).

The hydraulic conduit 14 is connected with the fuel supply system of the internal combustion engine. Said system comprises a fuel tank 15 and a delivery pump 16 which drives the fuel through a conduit 17, containing a filter 18, to the suction chamber 19 of the fuel injection pump 1. The maximum pressure attainable by the delivery pump 16 is determined by a check valve 16' disposed in a conduit 16'' bypassing pump 16. The hydraulic conduit 14 extends from the suction chamber 19 to the hydraulic cylinder assembly 9 through a pressure control valve 20 which maintains the pressure in the suction chamber 19 of the fuel injection pump 1 at a constant value between determined limits. From the hydraulic conduit 14 between the pressure control valve 20 and the hydraulic cylinder assembly 9, there extends a return conduit 21 terminating in the fuel tank 15. The flow passage section of the return conduit 21 is variable by means of a control slide 22 which is movable in the opening direction by means of an electromagnet 23 (stop magnet) against the force of a return spring 24. Thus, assembly 22, 23, 24 forms a solenoid valve. The electromagnet 23 is in an electric circuit 25 which includes a current source 26 and a manually operable (preferably by means of a key, not shown) electric switch 27 having four positions. In the figure, the switch 27 is shown in position I, in which the circuit 25 is open. In position II the electromagnet 23 is energized. In position III, in addition to the electromagnet 23, the electromagnet 4 and a glow plug 28 are energized. The latter serves to preheat the engine, as disclosed in U.S. patent to Sommer, No. 2,606,545, entitled "Control Device for Solid-Injection Internal Combustion Engines." In position IV, in addition to the afore-named elements 4, 23 and 28, a starting motor 29 for starting the internal combustion engine is supplied with current.

OPERATION OF THE PREFERRED EMBODIMENT

In the shown position of the movable parts of the system, the internal combustion engine is in an inoperative condition. There is no pressure in conduit 17 since the delivery pump 16, driven by the internal combustion engine is at a standstill. The switch 27 is in the position I and the return conduit 21 is closed by means of the slide 22. In order to start the internal combustion engine, the switch 27 is brought into position IV passing through positions II and III. Thus, in position II of switch 27, the electromagnet 23 displaces the slide 22 in the direction of arrow 22a, establishing communication between fuel tank 15 and cylinder chamber 12 so that in the latter no pressure build-up may take place. In position III, the electromagnet 4 (starting magnet) moves the bolt 3 in the direction of arrow 3a permitting the fuel quantity control member 2 to be shifted by a known mechanism (not shown) into a setting in which a fuel quantity required for starting the engine (in excess of the full load fuel quantities) is delivered by the fuel injection pump 1. Such known mechanism is disclosed, for example, in U.S. patent to Weber, No. 2,619,080, entitled "Fuel Injection System for Compression Ignition Engines." Also, in position III the glow plug 28 is energized and thus heat is generated. After starting the engine by the starting motor 29 (energized in position IV), the switch 27 is brought into position II for the normal operation of the internal combustion engine. In this position the electromagnet 4 is de-energized and, as a result, the bolt 3, not later than the first shifting of the fuel quantity control rod—for example, by means of an r.p.m.

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regulating device (not shown)—assumes its initial position shown in the figure. Thus, the maximum displacement of fuel quantity control member 2 is limited to full load fuel quantities.

For shutting off the internal combustion engine, the switch 27 is brought into position I. This de-energizes the electromagnet 23 (stop magnet) so that return spring 24 moves the slide 22 to close the return conduit 21. As a result, a hydraulic pressure builds up in the cylinder chamber 12. Thus a force is generated which, overcoming the force of spring 13, moves the piston 10 and the lever 6 into their position shown in broken lines. During the clockwise motion of lever 6, arm 6a engages pin 5 of the fuel quantity control member 2 and pulls the latter into a zero (no fuel delivery) setting shown in broken lines.

It is an advantage of the afore-described system that should electric power failure occur during the operation of the engine, the latter is automatically shut off since then the magnet 23 is de-energized, causing the slide 22 to close the return conduit 21. Should the hydraulic pressure generated by the delivery pump 16 drop (for example, due to a break or leak in the fuel line), then the engine automatically stops due to the lack of fuel.

It is a further advantage of this system that the engine may not be started by pushing the vehicle as long as the circuit 25 is in a deenergized condition. In convention diesel engines this highly undesirable possibility, among others, facilitates car thefts. According to the invention, when the vehicle is pushed, and the delivery pump 16 starts supplying pressurized fuel to the fuel injection pump 1, the latter may start operating, but the pressure in its suction chamber 19 will be immediately applied to piston 10 since the slide 22 blocks the return conduit 21. As a result, the fuel quantity control member 2 is immediately shifted by lever 6 into its zero position and the fuel injection pump is shut off.

The hydraulic servo-system according to the invention has the further advantage that the fuel quantity control rod 2 is moved into its zero position by the hydraulic setting means 6, 8, 10 in a gentle manner with progressive force. Thus, there is no danger of causing damage or destruction. The reason is that during engine run (i.e. at the moment when electromagnet 23 is energized), the pressure in conduit 14 is relatively small, but increases while the shutoff operation is in progress. This, in turn, may be explained by the fact that during shutoff, the fuel quantities delivered by the fuel injection pump 1 decrease, which causes an increase in the fuel return flow from suction chamber 19 through conduit 14. Thus, as a result of this phenomenon, when the return conduit 21 is closed by means of energizing the circuit 25, a slow-starting, but gradually accelerated pressure buildup will occur in chamber 12, causing first a slow, but then a progressively faster displacement of piston 10 and fuel quantity control member 2.

The electromagnet 23 (stop magnet), which, during the operation of the internal combustion engine, is continuously energized, may be arranged so that it is cooled by direct contact with the fuel stream flowing through conduit 21.

Since, for the hydraulic fluid operating the cylinder assembly 9, the fuel flowing through the suction chamber of the fuel injection pump is used, there is no substantial expense involved in the hydraulics (particularly conduits) of the system. Further, due to the force-amplification of the hydraulic servo system, the stop-magnet 23 may be designed in such a manner that it constitutes only a small load on the current source 26.

What is claimed is:

1. In a shutoff system for an internal combustion engine associated with a fuel supply system that includes a fuel injection pump forwarding metered quantities of fuel to said engine, a suction chamber and a shiftable fuel quantity control member forming part of said fuel injection pump, and a fuel delivery pump supplying said fuel injec-

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tion pump with fuel from a fuel tank, the improvement comprising

- (A) a hydraulic setting means operatively connected to said fuel quantity control member and adapted to assume a pressurized and a depressurized condition; said hydraulic setting means moving said fuel quantity control member into a zero or shutoff position when in said pressurized condition,
 - (B) a pressure conduit connecting said suction chamber of said fuel injection pump with said hydraulic setting means to place the latter into said pressurized condition by means of fuel returning from said fuel injection pump,
 - (C) a return or depressurizing conduit extending from said pressure conduit,
 - (D) a solenoid valve associated with said return conduit and placeable in an energized condition to open and in a deenergized condition to close said return conduit; said hydraulic setting means assuming its pressurized condition upon deenergization of said solenoid valve and assuming its depressurized condition upon energization of said solenoid valve, and
 - (E) electric circuit means for the arbitrary energization and deenergization of said solenoid valve.
2. An improvement as defined in claim 1, including
- (A) a bolt means movable into an advanced position limiting the maximum displacement of said fuel quantity control member to a setting in which said fuel injection pump delivers full load fuel quantities, said bolt means movable into a retracted position permitting said fuel quantity control member to assume a setting in which said fuel injection pump delivers starting fuel quantities that are in excess of said full load fuel quantities, and
 - (B) an electromagnet associated with said bolt means and energizable and de-energizable by said actuating element for causing movement of said bolt means.
3. An improvement as defined in claim 2, including an electric circuit to which there are connected a current

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source, a starting motor, said actuating element, said electromagnet and said solenoid valve; an electric switch adapted to assume a position I in which said circuit is de-energized, a position II in which said solenoid valve is energized, a position III in which said electromagnet and said solenoid valve are energized and a position IV in which said electromagnet, said solenoid valve and said starting motor are energized.

4. An improvement as defined in claim 3, including a glow plug connected in said circuit and energized when said electric switch is in said position III and IV.

5. An improvement as defined in claim 1, wherein said hydraulic setting means is formed of

(A) a cylinder assembly having a piston reciprocable in a cylindrical space and

(B) means connecting said piston with said fuel quantity control member.

6. An improvement as defined in claim 5, wherein said cylindrical space is divided by said piston into a first and a second cylinder chamber, said improvement includes a spring means disposed in said second chamber to oppose the force of hydraulic pressure in said first chamber.

7. An improvement as defined in claim 1, including a pressure control valve disposed in said pressure conduit means to maintain pressure at an approximately constant value upstream of said pressure control valve.

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