

FIG.1

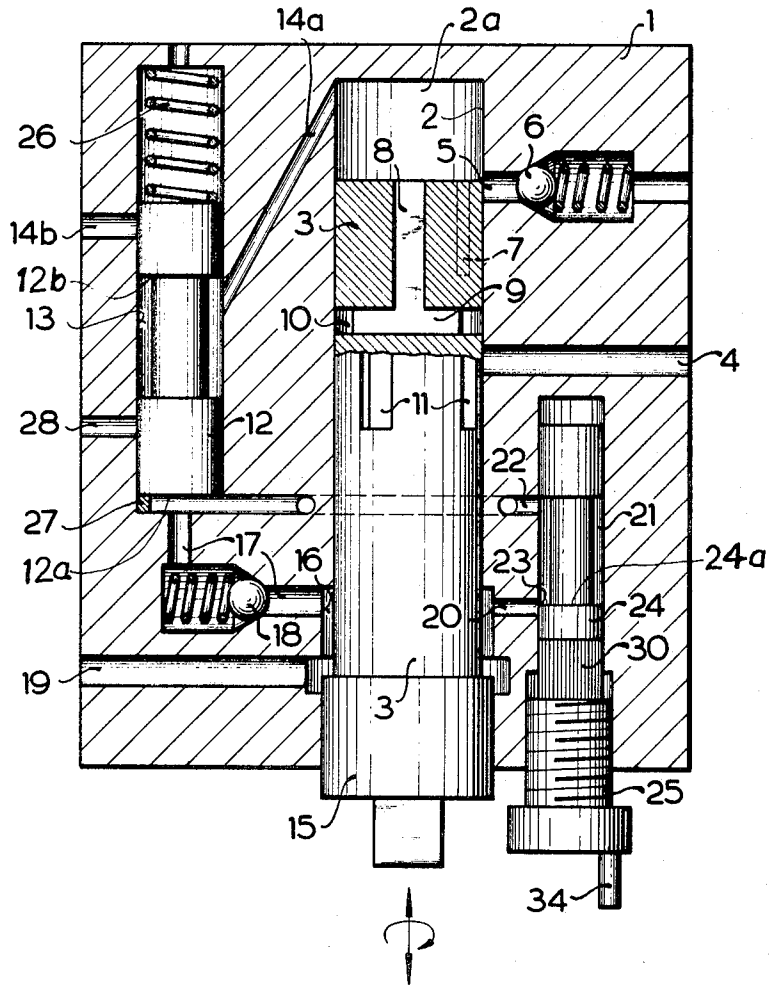
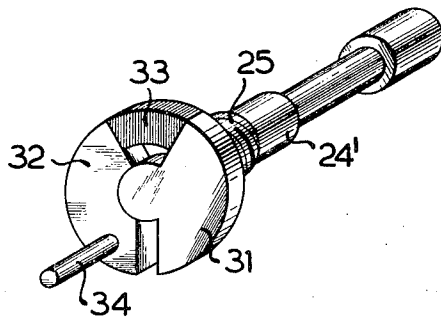


FIG.2



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FUEL INJECTION PUMP FOR INTERNAL-COMBUSTION ENGINES

BACKGROUND OF THE INVENTION

This invention relates to a fuel injection pump for internal-combustion engines and is of the type wherein the fuel quantity to be delivered to the engine is affected by an arbitrarily displaceable control plunger which, by means of a control edge, varies a throttle determining the flow rate of a liquid.

In a known fuel injection pump of this type (as disclosed, for example, in Austrian Pat. No. 227,480), the fuel quantities to be injected are determined by opening a bypass channel of the pump work chamber by means of a regular shuttle. The latter is caused to execute its forward strokes by a regulating liquid driven by an auxiliary pump which operates synchronously with the main fuel pump. During its return strokes, the regulator shuttle is braked by directing at least one part of the regulating liquid that caused its preceding forward stroke through the aforementioned variable throttle. As a result, for a predetermined flow passage section of said throttle and upon reaching a predetermined r.p.m., the regulator shuttle, due to the appearance of a so-called fluid abutment, does no longer return into its original position of rest. In such a case, the forward strokes of the regulator shuttle start from an advanced position of rest. As a result, the bypass channel of the pump work chamber is opened at an earlier moment and consequently, the delivered fuel quantities are decreased.

The magnitude of the flow rate through any given flow passage section of the throttle depends upon the viscosity of the liquid. As long as the regulating liquid is relatively cold and thus of relatively high viscosity (for example, during starting of a cold internal-combustion engine), the fluid abutment increases rapidly in case of a flow passage section set for idling. Consequently, the fuel quantities to be injected drop sharply. This is disadvantageous because the cold engine, due to the higher hysteresis, needs a greater quantity of fuel.

The foregoing applies not only to fuel injection pumps in which fuel quantity control is performed with the aid of a separate regulating fluid circuit, but also for pumps regulated by means of a suction throttle. In the last-named structures the flow rate of the fuel through a predetermined flow passage section depends upon the temperature of the fuel.

OBJECT AND SUMMARY OF THE INVENTION

It is an object of the invention to provide an improved fuel injection pump wherein the flow passage section determining the liquid flow varies automatically with the operating temperatures and thus with the change of the liquid viscosity, adjusting thereby the engine r.p.m.

Briefly stated, according to the invention, the throttle control means is formed of a first part which is arbitrarily adjustable, a second part which is a plunger that includes a control edge and a third part which is a heat expandable member causing relative displacements between the first and second parts as the temperature of the liquid passing through the throttle changes. As a result, a temperature-responsive change in the flow passage section of the throttle is obtained.

In addition to improve the starting conditions of the engine, the aforementioned adjustment of the engine r.p.m. is also advantageous in the maximum r.p.m. range to eliminate substantial fluctuations.

The invention will be better understood, as well as further objects and advantages will become more apparent, from the ensuing detailed specification of two exemplary embodiments of the invention taken in conjunction with the drawing.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is an axial diagrammatic sectional view of a fuel injection pump including a throttle control means forming the first embodiment of the invention; and

FIG. 2 is an isometric view of a throttle control means according to a second embodiment of the invention.

DESCRIPTION OF THE EMBODIMENTS

A pump housing 1 is provided with a bore 2 in which operates a main pump piston 3 driven by a mechanism (not shown) in such a manner that it executes an axial reciprocating motion as well as a rotary motion. Into bore 2 there merge an inlet channel 4 and a certain number of output or delivery channels 5, each of the latter containing a check valve 6. For the purpose of establishing communication between the pump work chamber 2a and one of the delivery channels 5 during each pressure stroke of piston 3, there is provided a longitudinal distributor groove 7 on the outer face of the piston 3. Further, for the fuel supply of the pump work chamber 2a during the return stroke of piston 3, the latter is connected with the supply channel 4 through an axial channel 8 which, on the one hand, merges in the pump work chamber 2a and, on the other hand, terminates in a transversal channel 9 which establishes communication with the supply channel 4 through an annular groove 10 and axially extending grooves 11.

To control the fuel delivery of the fuel injection pump during the pressure strokes of the pump piston 3, there is provided a regulator shuttle 12 which operates in a cylinder 13 and which controls a bypass channel formed of two channel portions 14a and 14b. The bypass channel portion 14a connects the pump work chamber 2a with the cylinder 13, while the bypass channel portion 14b connects the cylinder 13 with a chamber of lower pressure.

To cause forward strokes of the regulator shuttle 12, there is provided a regulating liquid which is delivered in a pulsating manner synchronously with the pressure strokes of the main pump piston 3. The regulating liquid is driven by means of an auxiliary piston 15 which is formed as a stepped portion of piston 3 and which operates in a cylinder 16. From the latter there extends a delivery conduit 17 through a check valve 18 to the lower end portion of the cylinder 13. A supply conduit 19 merges in the cylinder 16 and is controlled by the auxiliary piston 15.

Further, the cylinder 16 communicates with the lower end portion of the cylinder 13 by means of a channel 20 which leads from cylinder 16 to a cylinder 21 and by means of a channel 22 extending from cylinder 21 to cylinder 13. The opening through which the channel 20 merges into the cylinder 21 is throttled at 23. The free flow passage section of throttle 23 may be varied by the control edge 24a of a control plunger 24, the axial position of which may be set by means of a screw 25. To the latter there is affixed a pin 34 which may be connected with a mechanism (not shown) for the arbitrary actuation of screw 25.

The regulating liquid delivered by the auxiliary pump 15, 16 causes a forward stroke of the regulator shuttle 12 against the force of a return spring 26 which tends to maintain the regulator shuttle 12 in its position of rest determined by an abutment 27.

The forward stroke of the regulator shuttle 12 is terminated at the moment when its lower control edge 12a opens a bypass channel 28. At the moment when the regulator shuttle 12 establishes communication between the two bypass channel portions 14a and 14b by means of the control edge 12b, the fuel delivery from the pump work chamber 2a through the delivery channel 5 is interrupted, since the fuel, during the remainder of the pressure stroke of piston 3, is driven thereby through the bypass channel 14a, 14b.

The return stroke of the regulator shuttle 12 is braked by the regulating liquid which is displaced from the cylinder 13 through the throttle 23 by the returning regulator shuttle 12. Beyond a determined operational speed of the pistons 3 and 15, the regulator shuttle 12, due to the aforementioned braking effect, will be forced by the regulating liquid to execute the next forward stroke before returning to its initial position of rest determined by the abutment 27. This phenomenon is the so-called fluid abutment, by virtue of which the stroke of the

regulator shuttle 12 necessary for establishing communication between the bypass channel portions 14a and 14b becomes shorter. It will be understood that the more the operating speed of the pistons 3 and 15 increases for the same flow passage section of throttle 23, the shorter will be the

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aforenoted stroke of the regulator shuttle 12.

The r.p.m. of the engine is determined by the setting screw 25. To each position of screw 25 and thus to each flow passage section of throttle 23, there corresponds a certain r.p.m. The regulating fluid, however, is more viscous in a cold condition than at normal temperatures so that in case of a cold regulating liquid because of the more viscous and thus smaller fuel quantities flowing through the throttle 23 during each return stroke of the regulator shuttle 12, the fluid abutment rises more rapidly and the fuel injection pump cuts off earlier. In case of a cold engine such occurrence leads to stalling.

In order to prevent such a disadvantageous effect, according to the invention, between the control plunger 24 and the setting screw 25 there is disposed, in engagement with both, a heat expandable member 30. The latter, which may be made of a synthetic material or metal (bimetallic element) expands in response to warmer temperatures and contracts at colder temperatures. Such changes in the dimension of the heat expandable part 30 cause an axial shift of the control plunger 24 varying the flow passage section of throttle 23. In this manner it is achieved that for a given setting of screw 25, the flow passage section 23 is smaller at higher temperatures than at lower temperatures. Thus, the viscosity differences of the regulating liquid caused by the temperature variations are compensated and, as a result, the throttling function of the regulator shuttle 12 is not affected by the temperature of the regulating liquid. Stated in other terms, under identical engine loads, a certain setting of the screw 25 always corresponds to one certain r.p.m.

Turning now to FIG. 2, there is shown a second embodiment of the throttle control means associated with throttle 23. This throttle control means comprises a control plunger 24' and a setting screw 25 having a first head segment 31 integral therewith. A second head segment 32 is held concentrically and coplanar with the first head segment 31 and is rotatable relative thereto. Between the two segments 31 and 32 there is disposed a heat expandable member 33 also having a segment-like configuration. As the segment 33 expands or contracts in response to temperature changes of the regulating liquid, the head segments 31 and 32 are displaced angularly with respect to one another. As a result, the control plunger 24' is displaced varying the flow passage section of throttle 23.

To the segment 32 there is affixed a pin 34 by means of which the screw 25 may be arbitrarily turned and thus the flow passage section of throttle 23 varied. Any setting force exerted on pin 34 is transmitted by the segment 32 on the segment 31 through the heat expandable segment 33. Each angular position of the segment 32, that is, each position of the pin 34, corresponds for the same load conditions to one certain r.p.m., since the temperature differences which determine the viscosity of the regulating liquid are compensated by means of the heat expandable segment 33 in a manner described in connection with the first embodiment.

What is claimed is:

1. In a fuel injection pump associated with an internal-combustion engine, the improvement comprising,

A. a piston delivering fuel, during its pressure strokes, to said engine,

B. means for controlling the fuel quantity delivered to said engine by said piston during its pressure strokes, said last-named means including

1. a variable throttle opening determining the flow rate of

fuel passing therethrough for setting said fuel quantity,

2. a movable control plunger adjacent said throttle opening for varying the flow passage section thereof,

3. an arbitrarily movable part connected with said control plunger for setting the flow passage section of said throttle opening to a desired value and

4. a heat expandable member responsive to the temperature change of said fuel, said heat expandable member being in engagement with said control plunger to cause displacement thereof relative to said arbitrarily movable part for varying said flow passage section upon variations of said temperature.

2. An improvement as defined in claim 1, wherein said heat expandable member is in engagement with said arbitrarily movable part to constitute a motion transmitting means between said arbitrarily movable part and said movable control plunger.

3. An improvement as defined in claim 2, wherein said heat expandable member is disposed axially between said control plunger and said arbitrarily settable part; the changes in dimension of said heat expandable member effect an axial displacement of said control plunger with respect to said arbitrarily settable part.

4. An improvement as defined in claim 2, wherein said control plunger is integral with a threaded portion or screw to be axially displaced by rotation and with a segment head; said arbitrarily settable part is formed as a segment member arranged adjacent and rotatable with respect to said segment head, said heat expandable member has a segment configuration and is inserted between said segment head and said segment member, the changes in dimension of said heat expandable member effect an axial displacement of said control plunger by rotation with respect to said arbitrarily settable part.

5. In a fuel injection pump associated with an internal-combustion engine, the combination comprising

A. a main piston delivering fuel, during its pressure strokes, to said engine,

B. a pump work chamber from which said fuel is displaced by said main piston,

C. a bypass channel extending from said pump work chamber,

D. a regulator shuttle executing alternating forward strokes and return strokes, said regulator shuttle opening said bypass channel during said forward strokes to interrupt delivery of fuel from said pump work chamber to said engine during one part of each pressure stroke of said main piston,

E. a regulating liquid,

F. an auxiliary piston operating synchronously with said main piston and driving said regulating liquid with an r.p.m.-dependent pressure against said regulator shuttle to cause the forward strokes thereof,

G. return means exerting a force on said regulator shuttle against the pressure of said regulating liquid,

H. a return channel,

I. an arbitrarily variable throttle in said return channel; said regulator shuttle being braked during its return strokes, by said regulating liquid forced by said regulator shuttle through said return channel and said arbitrarily variable throttle and

J. arbitrarily displaceable means to vary the flow passage section of said throttle, said last named means including

1. a control plunger to directly vary said flow passage section by displacement and

2. a heat expandable member responsive to the temperature changes of said regulating liquid and in engagement with said control plunger to cause displacement thereof upon variations of said temperature.

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