United States Patent

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[54] **FUEL INJECTION PUMP FOR INTERNAL-COMBUSTION ENGINES**
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[56] **References Cited**
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3,027,843	4/1962	Raibaud	417/293
3,391,641	7/1968	Eckert et al.	417/293
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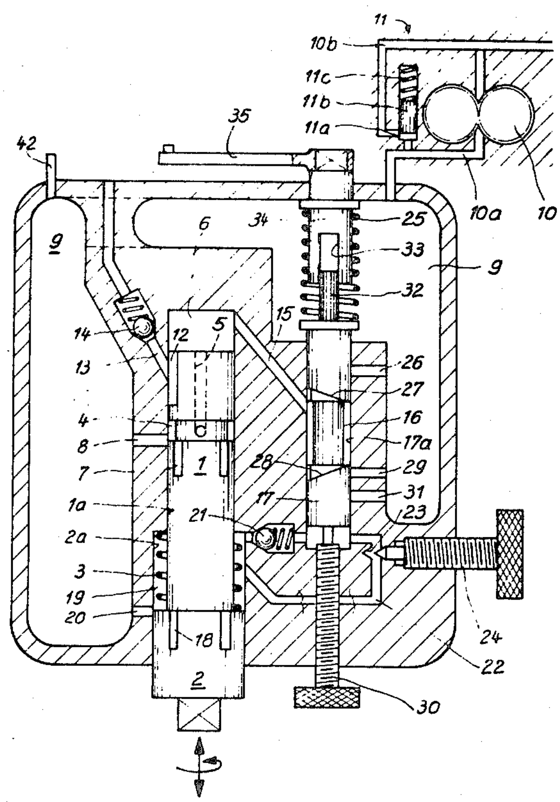
ABSTRACT: A fuel injector pump having a bypass from the pump chamber to a peripheral notch on a slide valve establishing connection to the suction chamber when the notch uncovers either one of two outlet ports. The notch is delimited by inclined edges and the slide valve is adjustable angularly and driven in synchronism with the main pump, whereby bypass intervals, during which no injection occurs, appear in the initial and terminal phase of each stroke with a duration depending on the angular position, which is controlled by the accelerator pedal with a stop being provided in dependence on the r.p.m.



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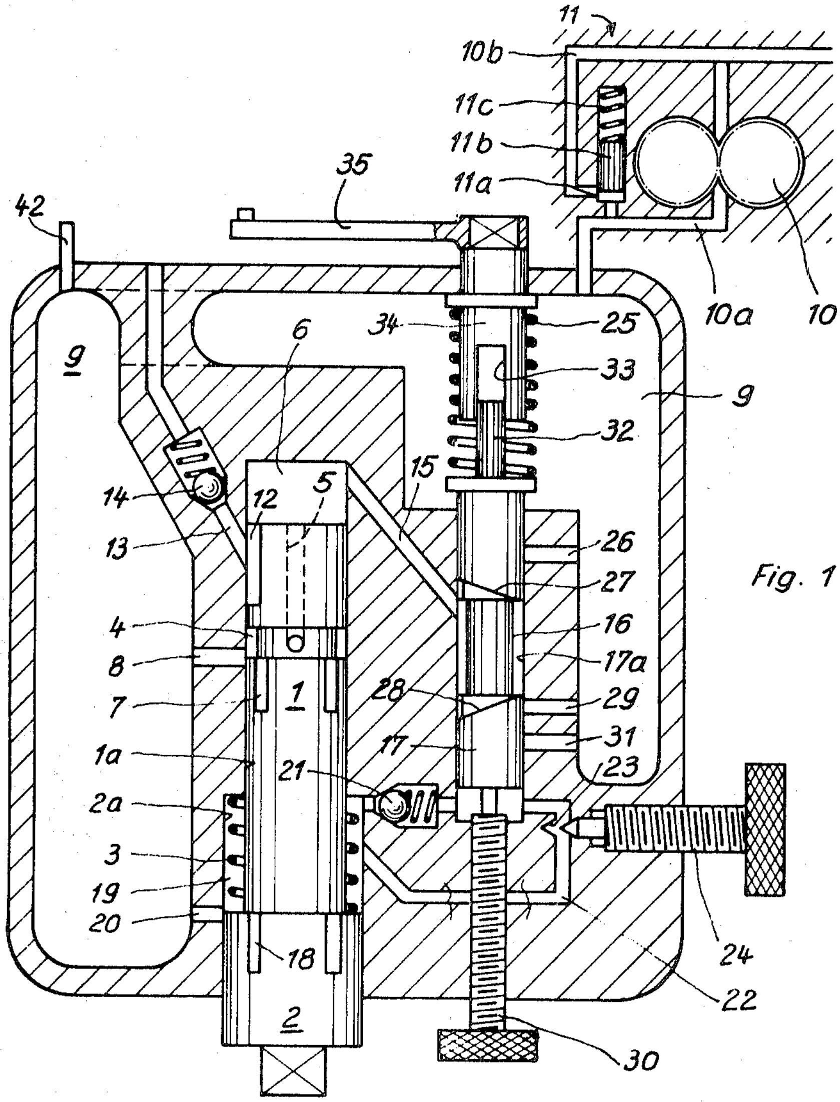

Fig. 1

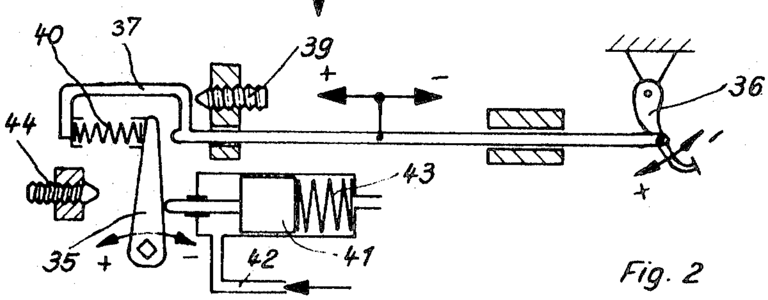

Fig. 2

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FUEL INJECTION PUMP FOR INTERNAL-COMBUSTION ENGINES

BACKGROUND OF THE INVENTION

The invention relates to a fuel injector pump for internal-combustion engines in which the rate of fuel supply is controlled in dependence upon the r.p.m.

An injector pump of this type is previously known, in which the pump action is interrupted at least during the occurrence of maximum r.p.m. through the operation of a bypass from the pump chamber back to the suction chamber during the active stroke of the piston under the control of a reciprocating control member which is operated in one direction by the pressure created by an auxiliary pump running in synchronism with the main pump and is braked during its return stroke. The return is effected by a biasing force and the braking action is caused by the control member having to force at least a portion of the pressure medium by which it was actuated back through a throttle-controlled channel, whereby the control member is subject to the action of a so-called fluid abutment for a certain throttle position and a certain speed and does not return all the way to its starting position at the fixed stop. The duration of the active interval may be controlled by turning of the control member, at least one inclined control edge being provided thereon delimiting the peripheral notch in the axial direction.

In the fuel injector of this type described in U.S. Pat. No. 3,417,703, the idling r.p.m. and the maximum r.p.m. are automatically determined by the control member (idling-terminal control characteristic), whereas in the intermediate speed range which is not subject to such control, the rate of fuel injection is controlled by the driver via the accelerator. In this known injector, there is no provision for controlling the initiation of injection simultaneously with this variation of the injection rate, as is often desirable. The idling-terminal control arrangement of this known injector requires an adjustable control throttle which must be coupled to the control member. This is a comparatively complicated arrangement.

SUMMARY OF THE INVENTION

The invention has for its object to provide a less complicated and less costly idling-terminal control in combination with a control of the initiation of injection in a fuel injector pump of the type referred to above, in which the rate of injection is controlled by turning of the control member, the duration of the active interval being variable owing to the inclination of a control edge.

This is achieved according to the invention by providing in a manner known per se from German Pat. No. 1,286,804 a second bypass for the pump chamber of the main pump which is subject to control by the control member, the second bypass being either continuously closed or becoming closed during the forward stroke of the control member by an inclined control edge after having passed through a section of its path, which varies in dependence on the angular position of the control member. Depending on the angular position of the control member, which in turn depends on the load and the position of the accelerator, the bypass is closed sooner or later to initiate the injection, resulting in a control of the initiation timing in dependence on loading conditions. At full load, i.e. with the accelerator all the way down, the second bypass is always held closed by the control member.

In a favorable embodiment of the invention, the bypasses are controlled by the edges delimiting a peripheral notch provided on the control member and serving as control edges, the notch being in constant connection with the pump pressure chamber. This results in a predetermined relationship of the initiation of injection and the control of the rate of injection by the driver.

In another preferred embodiment, the idling control of the injection pump takes place by means of a resilient drag coupling means for actuating the control member and which, in the course of a control movement towards full load, engages direct with a crank arm provided on the control member, whereas in the course of a movement towards idling, the crank arm is engaged via a spring. A control piston may be provided to engage the crank arm towards the full loading position in opposition to the resilient force and to be actuated towards full load position by a spring and towards idling position by a fluid, whose pressure varies with the r.p.m., whereby beginning at a predetermined pressure above the idling r.p.m. the control piston responds to the fluid pressure and disengages the crank arm. The terminal control of the r.p.m. occurs according to the known principle of fluid abutment.

THE DRAWING

An embodiment of the invention is shown in the drawing and will be described in more detail.

FIG. 1 is an axial section through an injector pump assembly.

FIG. 2 is a schematic representation on a reduced scale of the elements of the idling control.

DESCRIPTION OF EMBODIMENT

A section 1 of a stepped piston 1, 2 serves as the main pump and distributor piston of the injector pump and a section 2 as the piston of an auxiliary pump. Stepped piston 1, 2 is driven by means not shown in the drawing in a stepped cylindrical boring *1a*, *2a* so as to perform a reciprocating axial movement in combination with angular movement about its axis. The forward stroke of piston 1, 2 may be occasioned by a cam (not shown) and the backstroke by a spring 3. During the angular movement, section 1 of the piston serves as a distributor.

Piston section 1 possesses a peripheral notch 4 connected via a bypass channel 5 with the pressure chamber 6 of the injector pump. Connecting with notch 4 on the surface of the piston are longitudinal notches 7 for controlling an inlet boring 8. During a portion of the suction stroke of the pump fuel reaches chamber 6 from the suction chamber 9 of the injector pump via boring 8, one of longitudinal notches 7, peripheral notch 4 and boring 5.

Suction chamber 9 is supplied with fuel by a fuel pump 10, which may be driven by the engine to be supplied from the injector pump. In order to produce in suction chamber 9 a pressure which increases with engine r.p.m., there is connected to the outlet conduit *10a* of fuel pump 10 a pressure control valve 11 in the form of a slide valve *11b* controlling the cross section at a point *11a* of a return line *10b*. Slide valve *11b* is loaded on one side by the fuel pressure present in outlet conduit *10a* and in the opposite direction by a return spring *11c*.

Provided on the surface of piston section 1 is a distributing notch 12 which for each pressure stroke of the piston connects pump chamber 6 with one of a plurality of fuel supply channels 13, which are connected with the injection valves (not shown) of the engine and have provided therein individual outlet valves 14.

Pump chamber 6 is continuously connected via a bypass channel 15 to a peripheral notch 16 provided on a control member in the form of a governor slide valve 17 which is reciprocable in a cylinder *17a*.

Slide valve 17 is driven within cylinder *17a* by the fuel displaced by piston section 2 operating as an auxiliary pump in its cylinder section *2a*. The forward stroke of governor valve 17 therefor occurs during the pressure stroke of pump piston 1. Provided on the surface of piston section 2 are longitudinal notches 18 connecting with the pump chamber 19 of the auxiliary pump and serving during the suction stroke of the auxiliary pump to open a boring 20 which is in continuous connection with suction chamber 9. During the return stroke of auxiliary pump piston 2, boring 20 is closed thereby and fuel is supplied from pump chamber 19 via a nonreturn valve 21 to the space below governor valve 17 in cylinder *17a*. A portion of this fuel is also supplied via a channel 22, which also connects pump chamber 19 with cylinder *17a*. Provided in channel 22 is a throttle area 23, the cross section of which is controllable by means of a throttle needle 24. The fuel supplied by the auxiliary pump displaces the governor valve against the force of a spring 25, until notch 16 connects bypass channel 15 with an outlet port 26, which is in continuous connection with suction chamber 9. As soon as bypass 15 has been connected with port 26, the fuel injection action is stopped.

Serving to control port 26 is an inclined control edge 27 delimiting notch 16 peripherally so that according to the angular position of governor valve 17 channel 15 is connected to port 26 at an earlier, or at a later time. A second inclined control edge 28 also delimiting annular notch 16 controls an outlet port 29, which also connects with suction chamber 9. In the position of the governor valve shown in FIG. 1, port 29 is blocked. Turning of governor valve 17 opens up the connection to port 29 and at a certain angular position, it is fully opened. As soon as port 29 provides connection between notch 16 and chamber 9, it is possible during the initial phase of each pressure stroke of the pump piston for a portion of the fuel to flow back into suction chamber 9. However, since governor valve 17 is displaced by the fuel delivered by auxiliary pump 2, 2*a* in synchronism with the pump piston, port 29 will be closed after a certain portion of the stroke by the inclined control edge 28 in dependence on the angular position of governor valve 17. Not until this closure of port 29 has occured can the injection of fuel take place. The shape of control edge 28 is selected so as to cause the portion of the cross section of port 29 uncovered by control edge 28 to decrease with increased load until the port is totally blocked at full load.

To provide adjustment of the relationship between the initiation of injection and the loading, and adjustable stop 30 is provided for governor valve 17.

A third port 31 connects cylinder 17*a* with suction chamber 9 and is controlled by the lower end surface of governor valve 17 so as to open after the complete opening of port 26 brought about by inclined control edge 27 and thereby control the terminal position of governor valve 17 during the forward stroke.

An end section 32 of governor valve 17 extends into suction chamber 9 and is of flattened shape and slidable in a slot 33 provided in a coupling member 34, there being thus established between governor valve 17 and coupling member 34 a fixed coupling in the angular direction without detriment to the freedom of axial movement of the governor valve. Coupling member 34 is turnable by means of a crank arm 35.

FIG. 2 shows the means for actuating crank arm 35. The driver's actuation of accelerator 36 causes displacement of a resilient coupling means incorporating a link 37 in cooperation with a spring 40. The initial position of link 37 is determined by an adjustable idling stop 39. Link 37 can directly actuate arm 35 towards full load, but in the direction towards the idling position engagement is possible only with the interposition of spring 40. Furthermore, in the direction towards full load, arm 35 is acted on by a control piston 41, which is subjected to the pressure of a liquid acting in the direction towards idling, this pressure being controlled in dependence on the r.p.m. The liquid is supplied via a line 42 from suction chamber 9. In the direction towards full load, control piston 41 is biased by a spring 43. The maximum rate of fuel injection is controlled by an adjustable full load stop 44.

The idling terminal control and the control of the initiation of injection operate as follows:

As soon as the engine is started, crank arm 35 and with it governor valve 17 will be held by control piston 41 and spring 40 in an angular position corresponding to the desired idling r.p.m. As soon as this r.p.m. decreases, especially when the engine is cold, there is a decrease also in the hydraulic pressure obtaining in suction chamber 9 in dependence on he r.p.m. and consequently in the pressure in front of piston 41, causing spring 43 to displace the piston and arm 35 to a position corresponding to a higher rate of supply. On the other hand, upon an increase in r.p.m., arm 35 is rotated by spring 40 in response to the pressure in chamber 9 and in front of piston 41, which increases with the speed, causing actuation towards a lower rate of supply.

As soon as the driver actuates the accelerator to increase the rate of supply, the speed increases and causes piston 41 to be displaced against the force exerted by spring 43 and to disengage arm 35. Spring 40 then pushes arm 35 into contact with link 37. In the entire angular range between stops 39 and 44 it is now possible for the driver to control at will the amount of fuel supplied to the engine. The inclined control edges 27 and 28 are of opposite inclinations so that within this range of r.p.m. the initiation of injection is retarded in response to a decrease in the rate of fuel supply.

At full load, arm 35 is urged by link 37 into contact with stop 44, governor valve 17 being now in a position in which port 29 is continuously closed. At least in a portion of this range of full load r.p.m. governor valve 17 returns during each suction stroke of the pump piston to its initial positon at stop 30. However, upon a further increase in r.p.m., the so-called terminal control sets in, which is achieved in the present case by the so-called fluid abutment. During the return movement of the governor valve, nonreturn valve 21 causes the entire quantity of fuel displaced by the governor valve to flow through throttle area 23, which is adjusted so as to have a braking effect on the return movement of governor valve 17 at least in the terminal control range of r.p.m.'s. Above a certain r.p.m. of the pump, which is determined by the cross section of throttle area 23, the pressure stroke of auxiliary pump 2, 2*a* sets in before governor valve 17 has had time to return to its initial position. Owing to this fluid abutment acting on governor valve 17, it will start its return movement from an initial position which is spaced from stop 30, whereby port 26 will open up at an earlier time during the pressure stoke in response to control edge 27. This results in a decrease in the amount of fuel injected and therefore also in the r.p.m. of the motor supplied with the fuel. Throttle area 23 has a fixed adjustment such as to cause a desired P (degree of nonuniformity) of the terminal control to be achieved.

That which is claimed is:

1. A fuel injector pump assembly for an internal-combustion engine having an r.p.m.-dependent rate of fuel supply, comprising:

a main fuel pump having a pump piston reciprocating in a pump chamber,

a first bypass connected to said pump chamber,

a reciprocating control member for opening said bypass during the forward stroke of said pump piston,

an auxiliary pump operating in synchronism with said main pump to supply fluid to actuate said control member during the forward stroke thereof,

biasing means urging said control member back towards its initial position,

a return channel for the fluid supplied during the forward stroke of said control member,

a controllable throttle means in said return channel for creating a fluid abutment in dependence on said throttle means and on the r.p.m. before said control member returns to its initial position,

said control member being rotatable and having at least one control edge,

characterized by:

a second bypass connected to said pump chamber and controlled by an inclined control edge of said control member in dependence upon the angular position thereof to close said second bypass.

2. A pump assembly as claimed in claim 1, in which said bypasses comprise outlet ports controlled by the edges of a peripheral notch provided on said control member in connection with said pump chamber.

3. A pump assembly as claimed in claim 1, comprising an adjustable stop defining an initial position for said control member.

4. A pump assembly as claimed in claim 1, comprising resilient coupling means controlling angular position of said control member in response to the accelerator control thereof, said coupling means in response to a movement of the

accelerator control towards full load having direct engagement and in response to a movement towards idling position having resilient engagement by means of a spring with a crank arm angularly locked to said control member.

5. A pump assembly as claimed in claim 4, comprising a control piston for actuating said crank arm towards a full load position, a biasing spring urging said piston towards a full load position, and means for applying fluid pressure to said piston counteracting said biasing spring in dependence on the r.p.m. of said engine, thereby to cause said control piston above a predetermined r.p.m. to disengage said crank arm.