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Eheim

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[54] **R P M. REGULATOR FOR FUEL INJECTION PUMPS**

[72] Inventor: **Franz Eheim,** Stuttgart, Germany

[73] Assignee: **Robert Bosch GmbH,** Stuttgart, Germany

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[30] **Foreign Application Priority Data**

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[52] **U.S. Cl.** ....**123/179 L,** 123/139, 123/140
[51] **Int. Cl.** **F02n 17/08,** F02n 39/00, F02d 1/04
[58] **Field of Search** ....123/139 ST, 179 L, 179 A, 140 A, 123/139 AA, 139 AZ

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Primary Examiner—Mark M. Newman
Assistant Examiner—Ronald B. Cox
Attorney—Edwin E. Greigg

[57] **ABSTRACT**

In an r.p.m. regulator, the cutoff of additional fuel quantities required for the starting of an internal combustion engine, is effected by an r.p.m.-dependent pressure which displaces a starting piston against the force of a starting spring. In this manner, the starting spring, which, during starting r.p.m.s, causes the delivery of said additional fuel quantities, is neutralized and does not affect the fuel quantity control during normal engine operation.

3 Claims, 2 Drawing Figures

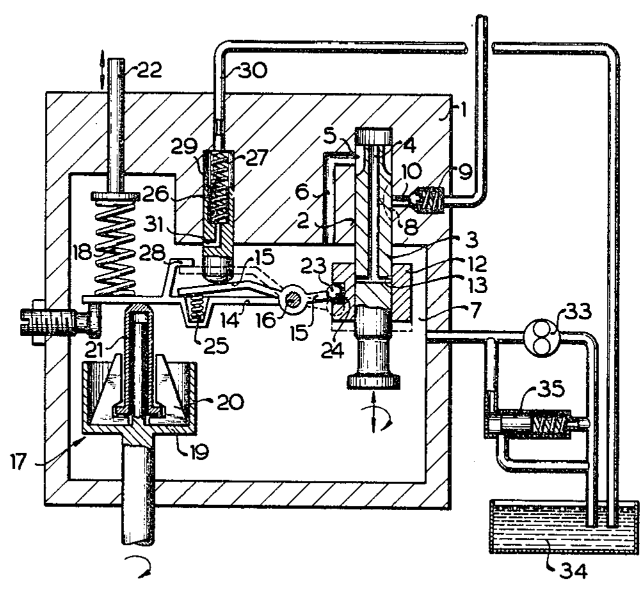

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FIG.1

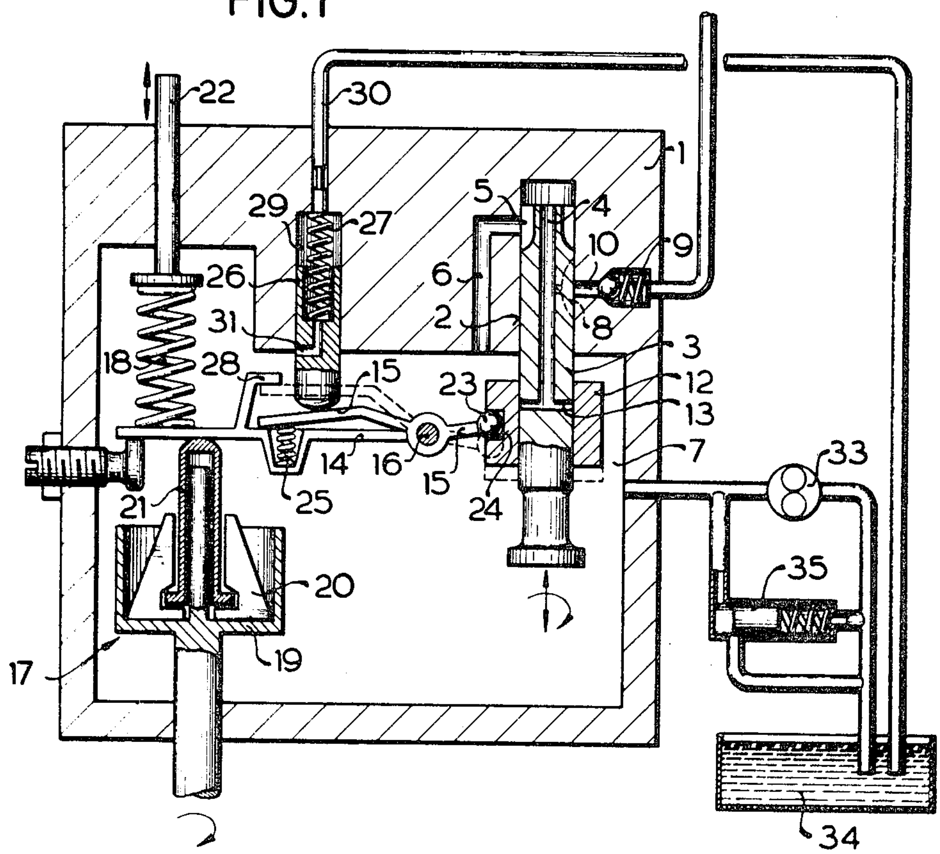
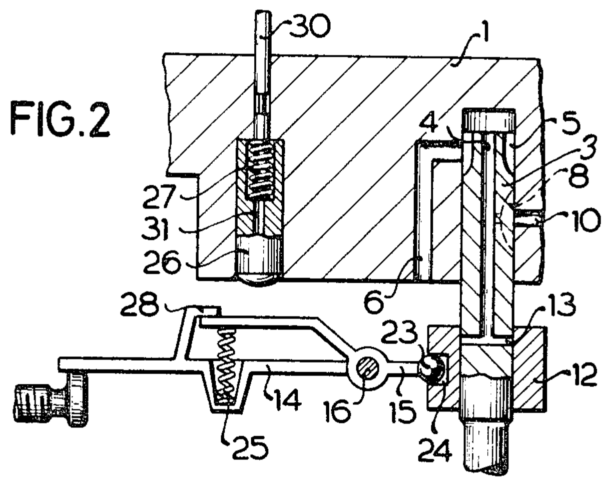


FIG.2



INVENTOR
Franz EHEIM
By

his ATTORNEY

R.P.M. REGULATOR FOR FUEL INJECTION PUMPS

BACKGROUND OF THE INVENTION

This invention relates to an r.p.m. regulator for fuel injection pumps and is of the type that is provided with an intermediate lever connected to and actuated by an r.p.m.-responsive member against the force of an arbitrarily adjustable regulator spring. Said intermediate lever is also connected to and actuated by a starting spring for delivering an additional fuel quantity required for starting the engine with which said pump is associated. The aforenoted forces imparted to the intermediate lever are transmitted thereby to a fuel quantity control member of the fuel injection pump.

In known r.p.m. regulators of the aforenoted type, as soon as the engine is at a standstill, the fuel quantity control member is shifted by the starting spring into a position in which the fuel injection pump, when the engine is started, delivers a fuel quantity which is in excess of the normally delivered fuel quantities. As soon as the engine is started with the aid of the aforenoted additional fuel quantities, its r.p.m. increases and an r.p.m.-responsive device, usually a centrifugal governor, causes the fuel quantity control member of the fuel injection pump to be shifted into a position in which the said additional fuel quantities are cut off. During such a shifting movement, the relatively soft starting spring is tensioned until the arbitrarily adjustable force of the regulating spring proper takes effect. It follows that the r.p.m.-responsive device has to travel a certain path before the r.p.m. regulation proper starts. This substantially limits the working capacity of the r.p.m.-responsive device. Centrifugal r.p.m. regulators of the known type further have the disadvantage that their working capacity in the starting r.p.m. range is very small and thus the r.p.m.-responsive device has to travel a substantial distance (for example, one-half of its entire path of travel), in order to tension the starting spring. This is disadvantageous in that it necessitates large dimensions of the regulator. Further, the force of the regulator spring proper is continuously affected by the force of the starting spring, since the regulator spring and the starting spring exert force on the same lever in the same direction. This effect is particularly strongly felt during idling at which time the regulator spring is only slightly tensioned.

OBJECT, SUMMARY AND ADVANTAGES OF THE INVENTION

It is an object of the invention to provide an improved r.p.m. regulator in which the aforenoted disadvantages are eliminated.

Briefly stated, according to the invention, the starting spring acts upon the intermediate lever through a starting piston axially displaceable in a fluidtight manner in the regulator housing, until said piston is displaced by an r.p.m.-dependent hydraulic pressure when the engine reaches a predetermined r.p.m. beyond the starting r.p.m.

By means of hydraulically cutting off the starting spring, the entire path of travel of the r.p.m.-responsive device is available for the quantity regulation, and the starting spring in no manner affects the operation of the regulator spring.

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

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a schematic sectional view of the preferred embodiment of the invention with the starting piston in its starting position and

FIG. 2 is a fragmentary view similar to FIG. 1 with the starting piston in its position assumed during the normal operation of the engine.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In a partially shown housing 1 of a fuel injection pump there is provided a cylinder 2 in which a pump piston 3 is caused to reciprocate and rotate by means not shown. During the return strokes of piston 3 and while it dwells at its lower dead center, the pump work chamber, which forms part of cylinder 2, is supplied with fuel through longitudinal grooves 5 provided in the outer face of the piston 3 and a supply channel 6 provided in the housing 1 and leading from a suction chamber 7. As soon as the longitudinal grooves 5 are hydraulically separated from the supply channel 6 after the piston 3 executed a predetermined portion of its pressure stroke, the fuel present in the pump work chamber is forced to one of the pressure conduits 10 through a longitudinal bore 4 provided within the piston 3 and a longitudinal distributor groove 8 provided in the outer face of the piston 3. Each pressure conduit 10 is provided with a check valve 9 and leads to the internal combustion engine, not shown.

On the piston 3 there is mounted an axially displaceable control sleeve 12 which does not participate in the reciprocating motion of piston 3. The latter contains a bypass channel formed of radial bore 13 and axial bore 4. The radial bore 13 continuously communicates through bore 4 with the pump work chamber and is blocked by the control sleeve 12 during one part of the reciprocating motion of piston 3. During a pressure stroke of the latter, as long as the radial bore 13 is closed by the wall of control sleeve 12, fuel delivery to the engine takes place through pressure conduits 10. As soon as the radial bore 13 emerges from control sleeve 12 during a terminal portion of the pressure stroke of piston 3, hydraulic communication is established between the pump work chamber and the suction chamber 7 through bypass channel 4, 13. As a result, the fuel, displaced by the continuing pressure stroke of piston 3, flows into the suction chamber 7 instead of pressure conduit 10. It is thus seen that the position of the control sleeve 12 assumed along the reciprocating path of piston 3 determines the fuel quantities delivered by the fuel injection pump during each pressure stroke of piston 3.

The control sleeve 12 is displaceable along the linear travelling path of piston 3 by a lever assembly formed of levers 14 and 15, both pivotable about a common stationary shaft 16. The lever 14, which at one end is pivotally mounted on shaft 16, is connected to and displaceable against the force of a regulator spring 18 by an r.p.m.-responsive device, such as a centrifugal governor generally indicated at 17. The support 19 of centrifugal weights 20 is driven with a speed identical to the pump r.p.m. By virtue of the outwardly swinging weights 20, a governor member 21 is displaced, causing a pivotal motion of lever 14. The preload of the regulator spring 18 may be arbitrarily adjusted through a bar 22.

One arm of the two-arm lever 15 projects with a spherical head 23 into a complemental depression 24 of the control sleeve 12. The other arm of lever 15 is urged into one direction by a linkage spring 25 supported by lever 14, and is urged into an opposite direction by a starting piston 26 loaded by a starting spring 27. To the lever 14 there is attached an integral detent member 28 which limits the pivotal motion of the lever 15 and which, during normal operation, holds the adjacent end of lever 15 urged thereagainst by linkage spring 25.

The starting piston 26 operates in a cylinder 29 provided in pump housing 1. The cylinder 29 is depressurized by a throttled channel 30. In the starting piston 26 there is arranged a bore 31 through which the fuel may flow from the suction chamber 7 through the throttled channel 30. The bore 31 is closed upon withdrawal of the starting piston 26 into the cylinder 29 to a small, predetermined extent.

The suction chamber 7 is supplied with fuel by means of a delivery pump 33 drawing fuel from a tank 34. By means of a pressure control valve 35, the pressure in the suction chamber 7 is controlled in a known manner as a function of the r.p.m. so that as the latter increases, the pressure in the suction chamber 7 also increases.

When the internal combustion engine and the fuel injection pump are inoperative, the r.p.m. regulator is in its starting position as shown in FIG. **1**. The starting piston **26** is pushed out of the bore **29** by the starting spring **27** to such an extent that the bore **31** communicates with the suction chamber **7** and the spring **25** is compressed. The adjacent arm of the lever **15** is urged into contact with the lever **14** by means of starting piston **26** urged by starting spring **27**. In this position, by means of the other arm of lever **15**, the control sleeve **12** is displaced to such an extent that bore **13** stays within the control sleeve **12** during substantially the entire reciprocating motion of piston **3**. Thus, as the engine is started, fuel is forced from the pump work chamber through the pressure conduits **10** to the internal combustion engine during substantially the entire pressure strokes of piston **3**.

As soon as the r.p.m. exceeds the starting r.p.m., the pressure in the suction chamber **7** increases due to the throttled channel **30** and displaces the starting piston **26** into the cylinder **29**, overcoming the force of starting spring **27**. Urged by the spring **25**, the lever **15** follows the aforenoted displacement of starting piston **26**, until the end of lever **15**, remote from head **23**, is stopped by the detent member **28**. Such a position of lever **15** is shown in broken lines in FIG. **1**. As the lever **15** moves from its position (starting position) shown in solid lines in FIG. **1** to its position-engaging detent member **28** (normal operating position) shown in FIG. **2** (or in broken lines in FIG. **1**), the terminal head **23** shifts the control sleeve **12** into a new position shown in broken lines in FIG. **1** and in solid lines in FIG. **2**. Thus, as it is apparent from a comparison of FIGS. **1** and **2**, the stroke of the pump piston **3** necessary for the radial bore **13** to emerge from control sleeve **12** and thus to establish communication between the suction chamber **7** and the pump work chamber, is substantially smaller for a position (normal operating position) of control sleeve **12** according to FIG. **2** than for a position (starting position) according to FIG. **1**. Thus, for normal operation, beyond the starting r.p.m.s, fuel delivery is cut off at an earlier point during each pressure stroke and consequently, the delivery of additional fuel quantities required for the starting of the engine is discontinued.

It is noted that once a sufficient pressure is built up in the suction chamber **7** and, in response, the starting piston **26** moves inwardly, the channel **31** is blocked by the wall of pump housing **1**. As a result, from that moment, a very rapid pressure increase will occur in suction chamber **7**, causing in turn, a very rapid inward movement of starting piston **26**.

After the additional fuel quantity required for starting has been cut off in a manner described hereinabove, further fuel quantity control is effected by moving the control sleeve **12** by means of the governor member **21** through lever assembly **14**, **15**. It is well seen in FIG. **2** that the fuel quantity control during normal engine operation (i.e., beyond the starting r.p.m.) is unaffected by the starting spring **27**, since the starting piston **26** is almost entirely withdrawn into the cylinder **29**, holding the starting spring **27** in a compressed condition.

What is claimed is:

1. In an r.p.m. regulator for a fuel injection pump associated with an internal combustion engine and having a driven reciprocating pump piston, the improvement comprising

A. a fuel quantity control means, the position of which determining the moment of fuel cutoff during each delivery stroke of said pump piston,

B. an r.p.m.-responsive device having a governor member for exerting an increasing force in a first direction upon an r.p.m. increase,

C. a chamber,

D. a starting piston slidably held for movement in said first direction and in an opposite, second direction and disposed in part in said chamber,

E. a starting spring urging said starting piston in said second direction into an operative or protruding position,

F. means for generating in said chamber an r.p.m.-dependent hydraulic pressure exerting a force on said starting piston in said first direction for moving said starting piston into an inoperative or withdrawn position beyond a predetermined r.p.m.,

G. a lever assembly including

1. stationary pivot means,
2. a first lever swingable about said pivot means and having a detent affixed thereto, said governor member being in contact with said first lever for moving the latter in said first direction towards said starting piston to an r.p.m.-dependent extent,
3. a second lever swingable about said pivot means and formed of
   a. a first arm engaging said fuel quantity control means,
   b. a second arm integral with said first arm and disposed in the path of motion of said starting piston, said second arm being moved away from said detent and into contact with said first lever by said starting piston in said operative position for the delivery of excess fuel quantities required for the starting of said engine,
4. a linkage spring disposed between said first lever and said second arm of said second lever for urging said second arm away from said first lever and into abutting contact with said detent and

H. a throttled discharge channel communicating with said chamber for slowing down the buildup of said r.p.m.-dependent pressure therein, said discharge channel closed by said starting piston upon travelling a predetermined distance under the effect of said hydraulic pressure in said first direction from said operative position into said inoperative position.

2. An improvement as defined in claim **1**, wherein said pump piston is provided with bypass channel means; said fuel quantity control means is formed of a control sleeve mounted on said piston and is displaceable along the path of reciprocation thereof by said lever assembly to control the closing and the opening of said bypass channel means.

3. An improvement as defined in claim **2**, wherein said chamber is a suction chamber of said fuel injection pump, said control sleeve is disposed in said suction chamber.

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