April 20, 1954 H. K. LINKS 2,675,795

HYDRAULIC REGULATING DEVICE FOR FUEL INJECTION PUMPS

Filed March 8, 1950

Fig. 1

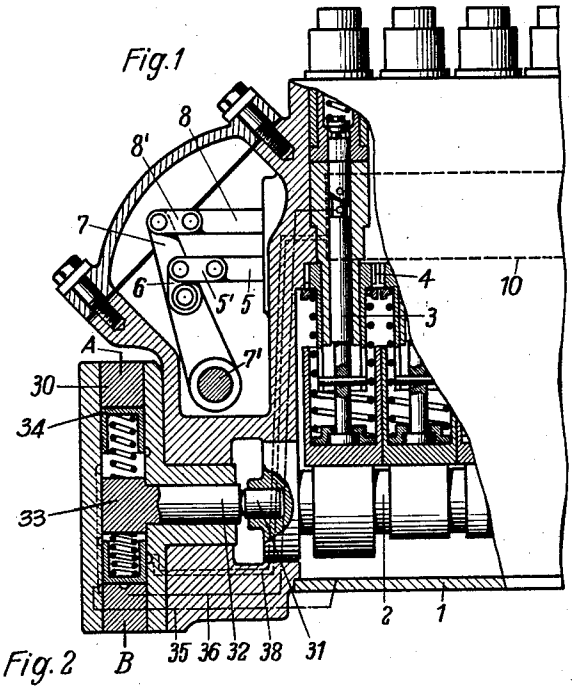



Fig. 2

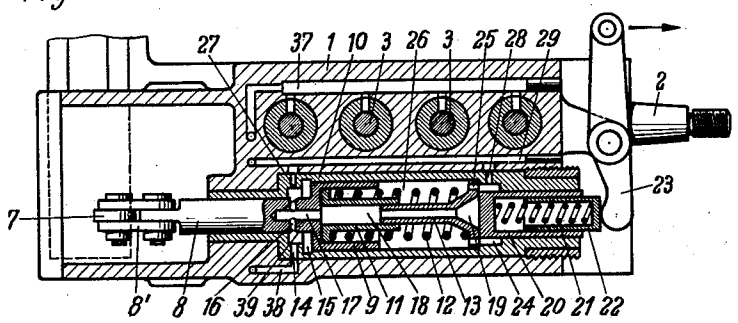



Fig. 3

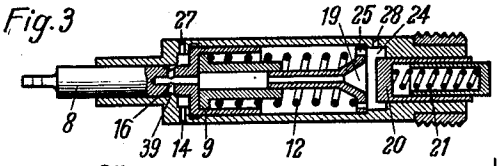
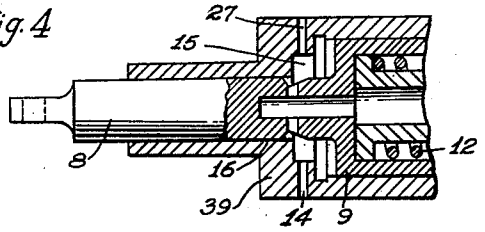



Fig. 4




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## HYDRAULIC REGULATING DEVICE FOR FUEL INJECTION PUMPS

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14 Claims. (Cl. 123—140)

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The invention relates to regulating devices for fuel injection pumps and particularly to regulating devices of the type in which the regulation is effected by variations in hydraulic pressure in accordance with engine speed.

The primary object of the invention is a device or governor of the above referred to type effecting a simple regulation of the quantity of injected fuel and at the same time acting as maximum speed governor.

Another object of the invention is a governor-injection pump unit which is of economical construction and is simple in its operation.

According to the present invention raising the hydraulic pressure will at first result in an increase of the quantity of injected fuel. However, if a predetermined hydraulic pressure is exceeded, there will be a reduction in the quantity of injected fuel or the injection of fuel may be cut off entirely. Preferably means are provided enabling the driver to increase or decrease that predetermined pressure at which the governor will start to decrease the injected fuel quantity.

Regulation is effected by having the hydraulic pressure act against the governor piston which is suitably biased, for instance by a spring. Whenever the hydraulic pressure has reached the above referred to predetermined value, the biasing force will be increased to such an extent that the governor piston will be moved to a position corresponding to a decreased quantity of injected fuel or to a position in which fuel delivery will be cut off entirely. Increasing the biasing force after a desired engine speed or a corresponding fluid pressure has been reached can for instance be accomplished by transferring fluid from the pressure side of the governor piston to its biased side, thus increasing the biasing force.

The invention has the advantage of combining in a simple and convenient manner a control of the quantity of injected fuel and a control of a desired maximum speed by decreasing or cutting off fuel delivery whenever a predetermined engine speed has been exceeded.

Further features and details of the invention will become apparent from the following description and drawings of an embodiment of the invention. Of the drawings:

Fig. 1 shows a partial side view and partial longitudinal sectional view of a governor-fuel injection pump unit;

Fig. 2 is a horizontal sectional view of the governor portion of the unit shown in Fig. 1, the governor piston being shown in a position corresponding to normal engine speed;

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Fig. 3 is a detail sectional view of the governor, showing the governor in a position corresponding to an engine speed in excess of a desired maximum speed;

Figure 4 is an enlarged partial sectional view of the details shown in Figure 3.

In the four cylinder injection pump shown in the drawings the pump housing is designated by the reference numeral 1, the pump camshaft by 2 and the pump pistons by 3. The quantity of injected fuel is controlled in the conventional manner by rotating the pump pistons by means of gears 4 and rack 5. Rack 5 is connected with a lever 7 by means of link 5' and the adjustable lever 6, the lever 7 being rigidly attached to the shaft 7'. Means actuated by the driver may be provided to turn the shaft 7' thereby changing the position of rack 5 which may for instance be moved to a position corresponding to zero fuel delivery. The lever 7 is also connected with the governor piston 9 by means of rod 8 and link 8'.

The governor piston 9 is slidably mounted in the governor cylinder 10 which is disposed in the pump housing. The piston 9 is biased by a spring 12, one end of this biasing spring bearing against a sleeve 11 which abuts the governor piston 9 and may be permanently fastened thereto, the other end of the biasing spring bearing against a guide bushing 13, the flange of which is rigidly attached to the governor cylinder 10.

The governor fluid may be fuel and may be supplied by a special pump. The fluid enters the pressure chamber 15 through opening 14 and acting upon the face of the governor piston 9 tends to force this piston to the right against the action of spring 12. One or several radial passages 16 connect to an axially extending passage 17 within piston 9, through which passages fluid may flow to a chamber 18 within sleeve 11 and from there through a passage provided in the guide bushing 13 into a conically shaped chamber 19 within the end portion of guide bushing 13, the bottom of chamber 19 being closed by a piston 20. The piston 20 is biased by a spring 21, the tension of which can be changed by moving a tappet 22 which is slidably mounted within piston 20, movement of the tappet 22 being effected by lever 23 which may for instance be connected to the accelerator pedal, the tension of spring 21 being comparatively low with the pedal in released or idling position and comparatively high

with the pedal in fully depressed or full load position.

As long as piston 20 is kept in abutment with the guide bushing by the action of spring 21 there will be no communication between the conical chamber 19 and the annular chamber 24 surrounding the upper end of piston 20. The annular chamber 24 is connected to the chamber 26 on the biased side of piston 9 by means of passages 25 provided in the flange portion of the guide bushing 13.

A throttling passage is provided in the governor cylinder 10 connecting the pressure chamber 15 with a passage 29. A similar throttling passage 28 connects the annular chamber 24 with the passage 29, the passage 29 being for instance in communication with the fuel tank or with the suction side of the governor fuel pump or with the suction side of the injection pump cylinders.

The fuel transfer and governor pump 30 are positioned in a separate housing bolted to the front end of the pump housing 1. The shaft 32 of this pump is coupled to the pump camshaft 2 by means of coupling 31. An eccentric 33 arranged on the free end of the shaft actuates a plurality of pump pistons 34 disposed radially to said pump shaft. The suction side of the pump 30 can for instance be connected to a fuel sump in housing 1 by means of a passage 35. The transfer pump can for instance be a pump of the type supplying fuel at two different pressures i. e. supplying fuel at a comparatively low pressure, for instance 2 atm., through conduit 36 to the inlet chamber 37 for the cylinders of the fuel injection pump and fuel at a comparatively high pressure, for instance 10 atm., through conduit 38 to the inlet opening 14 of governor cylinder 10. Ordinarily the pressure acting on the face of the governor piston is mainly determined by the cross sectional area of the throttling passage 27 and will increase with an increase in engine speed or with an increase in pump speed.

The fluid pressure within the pressure chamber 15 moves the governor piston to the right against the action of the biasing spring 12, the distance the governor piston is moved to the right depending on the speed of the engine. The more the engine speed increases the more the lever 7 or the rack 5 will be moved to the right thus increasing the quantity of injected fuel within the normal range of speed.

This increase in the quantity of injected fuel is, however, limited to a speed range below a predetermined maximum speed dependent on the one hand on the tension of the spring 21 and on the other hand on the fluid pressure. Fluid from pressure chamber 15 will enter the conical chamber 19 through passages 16, 17 and 18 and will act upon piston 20 which will be moved to the right as soon as the fluid pressure in chamber 19 exceeds the biasing force of spring 21. The biasing force of spring 21 is dependent on the position of lever 23 which can, as mentioned before, be adjusted by the driver in such a way that at no load the piston 20 will be displaced to the right already at low engine speeds and at full load only at higher engine speeds. Movement of piston 20 to the right enables fluid to flow from the conical chamber 19 to the annular chamber 24 or to the chamber 26 on the biasing side of the governor piston, thus wholly or approximately equalizing the pressure on both sides of the governor piston, so that the governor piston will now be moved to the left by the action of the biasing spring 12. Fluid pressure in chamber 26, apart from depending on the distance the piston 20 has moved to the right, also depends on the size of the throttling passage 28 which may have the same or for instance a smaller cross-sectional area than throttling passage 27. Means may be provided to regulate the flow of fluid through these throttling passages, which for instance can be designed as interchangeable inserts.

Movement of the governor piston 9 or of the rack 5 to the left decreases the quantity of injected fuel. Provision can also be made to throttle the rate of flow from the pressure to the biased side of the governor piston in relation to the position of this piston. This can for instance be effected by providing a conical control surface 39 on the piston rod 8 between passages 16 and the face of the governor piston. It can be seen that as the governor piston moves to the left the flow of fluid through the passages 16 or to the biased side of the piston will be increasingly throttled, thereby increasing the pressure in chamber 15 and thus equalizing the forces acting on both sides of the piston.

If fuel injection is to be cut off completely this will preferably be effected by manually moving lever 7 or rack 5 to a position corresponding to zero fuel delivery.

The invention is not limited to the embodiment shown, but it will be understood that various changes in details of construction and arrangement may be made by those skilled in the art without departing from the spirit of the invention as set forth in the appended claims.

What I claim is:

1. Hydraulic regulating device for a fuel injection pump system, responsive to engine speed wherein regulating fluid at a pressure dependent on the engine speed is provided comprising at least one injection pump cylinder, inlet and outlet means for said injection pump cylinder, a pump piston within said injection pump cylinder, actuating means for said pump piston, means for regulating the quantity of fuel injected by said pump piston, a hydraulic governor operatively linked to said quantity regulating means, a cylinder for said governor, said governor including a governor piston slidably mounted in said cylinder and acted upon by said fluid, pumping means for providing fluid under pressure to said hydraulic governor, biasing means for said governor piston and means to control the bypassing of fluid from the pressure side to the biased side of said governor piston, said control means bypassing fluid only after the fluid pressure on the pressure side of said governor piston has exceeded a predetermined pressure.

2. A fuel injection pump system according to claim 1, in which said governor piston is provided with passages for bypassing hydraulic fluid therethrough.

3. A fuel injection pump system according to claim 1 in which manually or foot operated means are provided for adjusting the setting of said quantity regulating means and of said bypass control means in such a way that, if the quantity of injected fuel is increased by adjusting said quantity regulating means, said predetermined pressure is also increased by increasing the biasing force acting on said control valve.

4. A fuel injection pump system for exercising hydraulic pressure comprising at least one injection pump cylinder, inlet and outlet means for

said injection pump cylinder, a pump piston within said injection pump cylinder, means for actuating said pump piston, means for regulating the quantity of fuel injected by said pump piston, a governor cylinder, a pressure chamber in said governor cylinder, pumping means for providing fluid under pressure to said pressure chamber within said governor cylinder, a throttling passage for discharging fluid from said pressure chamber, a spring biased governor piston slidably mounted within said governor cylinder and acted upon by said fluid, said governor piston being linked to said quantity regulating means, means to control the bypassing of fluid from the pressure side to the biased side of said governor piston, said control means bypassing fluid only, after the fluid pressure on the pressure side of said governor piston has exceeded a predetermined pressure, and a throttling passage for discharging bypassed fluid from said governor cylinder.

5. A fuel injection pump system according to claim 4 in which said governor piston is provided with passages to permit fluid to be bypassed from the pressure side to the biased side of said governor piston, a guide bushing having a chamber disposed within a guide bushing, said chamber being open on one side, said guide bushing being rigidly attached to said governor cylinder and serving as support for one end of said biasing spring of said governor piston, said open side of said chamber being provided with and closed by a spring biased control piston, as long as the pressure of said biasing spring of said control piston exceeds said predetermined hydraulic pressure.

6. A fuel injection pump system according to claim 1 in which said pumping means comprise a fuel transfer pump supplying fuel to said injection pump cylinder as well as to said hydraulic governor, said fuel serving as fluid for acting upon said governor piston.

7. A fuel injection pump system according to claim 6 in which said fuel transfer pump supplies fuel to said governor at a higher pressure than to said fuel injection pump cylinder.

8. Hydraulic regulating means, responsive to engine speed, for fuel-injection pumps of an internal combustion engine of the injection type, pumping means wherein regulating fluid at a pressure dependent upon the engine speed is provided, a regulating piston for said pumping means, a hydraulic governor for urging said piston against a resisting force, in the direction for increasing the quantity of fuel to be injected, but when the said pressure exceeds a predetermined value the resisting force is increased so that the regulating piston is urged thereby in the direction for reducing the quantity to be injected, said regulating piston being provided with a passage whose opening is controlled automatically in dependence on the fluid pressure and through which the regulating fluid can pass to the opposite side of the piston for increasing the resisting force as aforesaid.



9. Regulating means according to claim 8, wherein the opening of the piston passage is controlled by a hollow sliding valve member which is subject to controlling spring pressure and is disposed co-axially with the piston, the arrangement being preferably such that the predetermined fluid pressure, above which the valve opens and allows the regulating fluid to pass to the opposite side of the piston, can be increased with movement of the output controlling member of the engine, for example an accelerator pedal, in the direction for increasing the engine output.

10. Regulating means according to claim 8, wherein upon displacement of the regulating piston towards the cut-off position, access of regulating fluid to its opposite side is throttled or cut off by a further piston or slide valve, preferably connected directly on the regulating piston.

11. Regulating means according to claim 8, wherein each of the spaces on the two sides of piston acted upon by the regulating fluid is in communication through a constricted opening with a return passage for the regulating fluid, the opening from the side of the piston acted upon continuously or normally by the regulating fluid being preferably larger than that from the opposite side.

12. Regulating means according to claim 8, in which said pumping means is a fuel transfer pump for supplying fuel to said fuel-injection pump as well as to said hydraulic governor, said fuel serving as fluid for acting upon said governor piston.

13. Regulating means according to claim 12, wherein the regulating fluid pressure is substantially higher than the pressure of the fuel supplied to the injection pump.

14. Regulating means according to claim 12 disposed parallel to a row of injection-pump cylinders, the regulating means and a supply pump are combined with the injection pump to form a single unit in a common housing.

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