April 21, 1942. S. MEISWINKEL 2,280,496

LIQUID PRESSURE REGULATOR FOR INJECTION PUMPS

Filed May 3, 1938 2 Sheets-Sheet 1

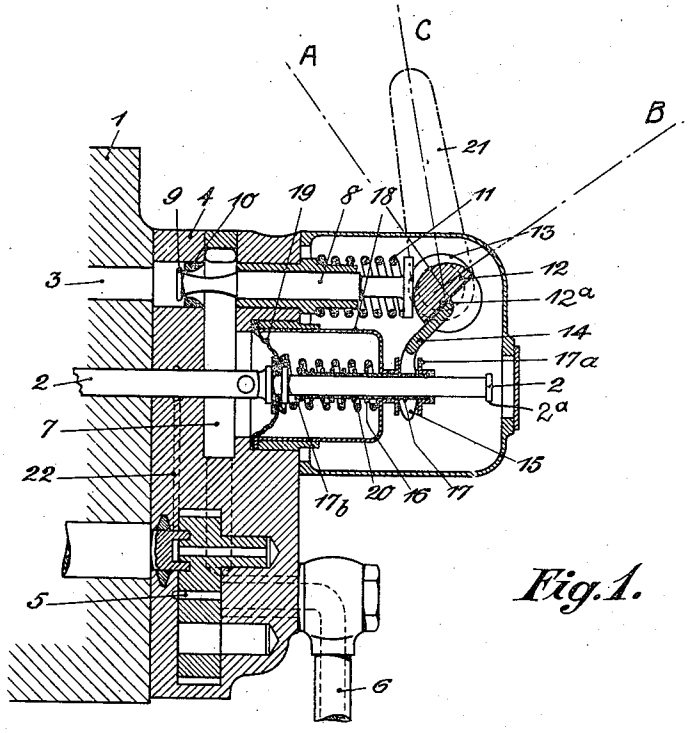


Fig. 1.

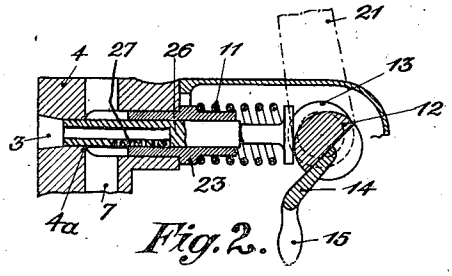


Fig. 2.

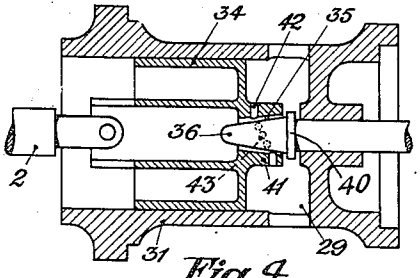


Fig. 4.

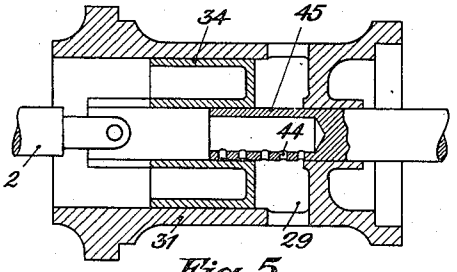


Fig. 5.

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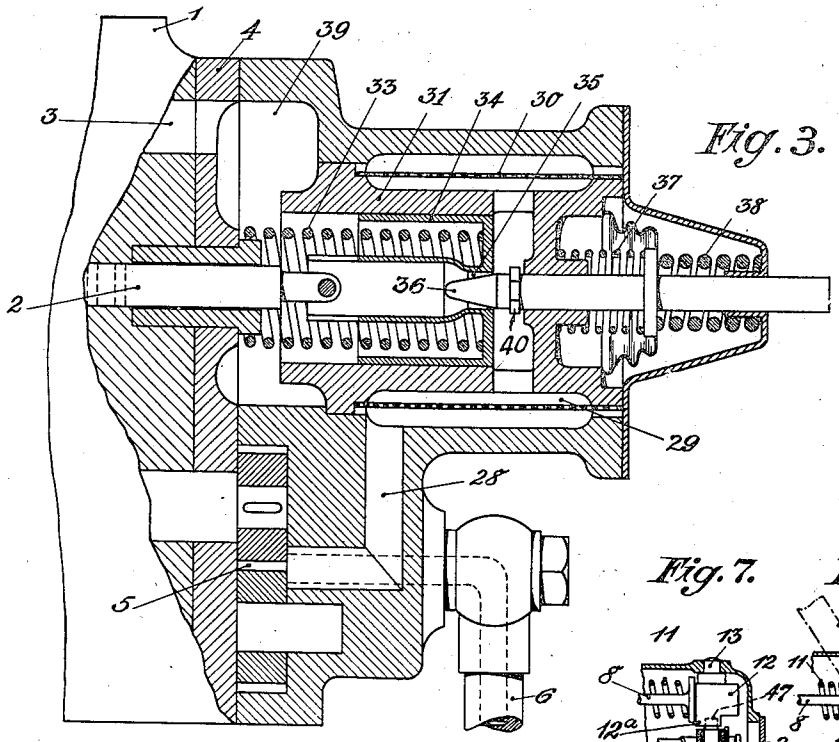


Fig. 3.

Fig. 7.

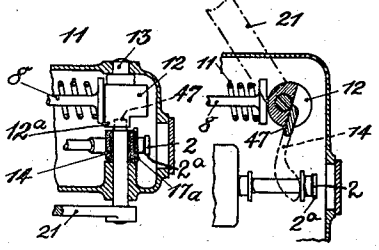


Fig. 8.

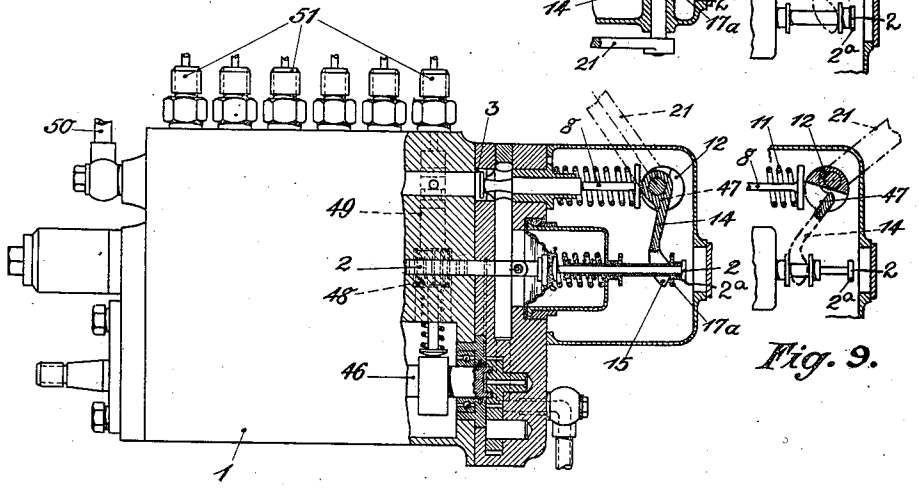


Fig. 9.

Fig. 6.

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UNITED STATES PATENT OFFICE

2,280,496

LIQUID PRESSURE REGULATOR FOR INJECTION PUMPS

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Application May 3, 1938, Serial No. 205,687
In Germany May 7, 1937

8 Claims. (Cl. 123—140)

The present invention relates to improvements in fuel injection devices for internal combustion engines, and more particularly to control mechanisms for fuel injection pumps to which the liquid fuel is supplied by means of an engine driven pressure pump.

One object of the invention is to provide a fuel injection device in which the operation of the injetcion pumps is controlled in such a manner as to maintain a constant speed of operation of the engine at any particular setting of a control.

Another object of the invention is to provide a control mechanism for a fuel injection pump, the range of which varies in dependence upon the adjusted position of a throttling member in the pressure conduit between fuel feed pump and injection pump.

Other objects will become apparent as the description proceeds.

Several embodiments of the invention are illustrated by way of example in the accompanying drawings, in which:

Fig. 1 shows in longitudinal section one embodiment of a control mechanism for a fuel injection pump according to the invention, including a cone valve.

Fig. 2 shows a throttle sleeve of a modified construction.

Fig. 3 shows in longitudinal section a regulating arrangement in which the control piston of the regulating rod forms part of the throttle device.

Fig. 4 is a detail view showing in longitudinal section a regulating and throttle piston of modified construction.

Fig. 5 shows in longitudinal section the throttle piston according to Fig. 3 with a register throttle sleeve.

Fig. 6 shows the general arrangement of a fuel injection device according to the invention with a control mechanism as shown in Fig. 1 partly in elevation, partly in section.

Fig. 7 is a top plan view of the control mechanism of Figs. 1 and 6.

Fig. 8 shows the cam disc of the control mechanism according to Figs. 1 and 6 in stop position.

Fig. 9 shows the cam disc of the control mechanism in full-load position.

In the general arrangement illustrated in Fig. 6, the housing of a fuel injection pump is designated by 1 and accommodates six high pressure plungers 49. The fuel is fed into the stroke chambers of the high pressure plungers through a conduit 3 and flows through the pressure conduit connections 51 to the injection nozzles. The plungers are actuated by a cam shaft 46. Each plunger 49 carries a spur wheel 48 engaged by the rack of a regulating rod 2. The feed quantity of the fuel is regulated in the usual manner by turning the pump plunger. Any excess fuel flows back to the fuel tank (not shown) through the conduit 50, preferably provided with a valve.

A cover plate 4 is flanged on to the pump housing and serves as bearing for a control mechanism. The control mechanism comprises a gear wheel pump 5 to which fuel flows through a conduit 6. The gear wheel pump is driven by the crank shaft of the injection pump, and, as this latter is driven by the internal combustion engine, the gear wheel pump participates in all fluctuations in the speed of the engine. Consequently, the quantity of liquid delivered by the pump into the pressure conduit 7 varies accordingly. The pressure conduit 7 is connected with the feed conduit 3. At the point where the feed conduit 3 branches off from the pressure conduit 7 a throttle device is arranged. This throttle device comprises a slide valve stem 8 projecting into the feed conduit 3 and carrying a conical valve head 9 cooperating with a valve seat 10. A spring 11 tends to hold the valve in closed position and at the same time maintains the stem 8 in positive contact with a cam disc 12 integral with two axles 13. A lever 14 is swingably mounted with its upper end on one of the axles 13 and has a forked lower end 15. The cam disc 12 comprises a cylindrical portion from which a segment is cut away to produce a surface 12a. The lever 14, on the side thereof facing the cam disc 12, carries a cam with a surface 47 against which the surface 12a of the cam disc bears. The fork 15 of lever 14 engages a sleeve 17 mounted slidably on the regulating rod 2 and loaded by a spring 16, said sleeve being guided resiliently in a spring housing 18. The spring housing 18 serves at the same time as clamping member for a diaphragm 19 which is connected with the regulating rod 2 and serves as control member for this rod. One side of the diaphragm 19 is exposed to the pressure of the liquid delivered by the gear pump 5 into the conduit 7 and the other side is acted upon by a strong spring 20 accommodated in the housing 18 and surrounding the spring 16. An adjusting lever 21 is keyed to one of the cam axles 13 and actuated by hand or foot through the intermediary of a lever system not shown on the drawings. A conduit 22 connected to the suction side of the gear pump 5 serves to suck off any liquid creeping along the rod 2 from the conduit 7.

The arrangement illustrated in Fig. 1 operates in the following manner:

The regulating rod 2 when pushed towards the right adjusts the injection pump towards its stop position and when pushed towards the left it adjusts said pump towards its full load position. The stop position of the lever 21 is established by swinging this lever towards the left (position shown in Fig. 6 and indicated by line A in Fig. 1) whereas its extreme position towards the right corresponds to full-load (Fig. 9 and line B in Fig. 1). When the lever 21 is swung from the intermediate operative position C shown in Fig. 1 into the stop position A (Figs. 6 and 8), the surface 12a of the cam 12 presses against the surface 47 of the lever 14 and thus shifts this lever to the position shown in Figs. 6 and 8.

If the internal combustion engine starts at medium speed, the gear pump 5, also rotating at medium speed, delivers a medium quantity of liquid into the conduit 7, and the thrust force of this liquid acting on the diaphragm 19 forces the regulating rod 2 into an intermediate position against the action of spring 20. At the same time the throttle aperture 9, 10 at the mouth of the feed conduit 3 is opened sufficiently to enable a quantity of fuel corresponding to the actually prevailing running conditions to flow through this aperture.

If the engine tends to increase its speed, the output of the gear wheel pump 5 and the pressure of the liquid on the diaphragm 19 starts to increase. Consequently, the regulating rod 2 is pushed further towards the right with the result that the fuel feed to the injection nozzles is throttled so as to counteract the increase of speed.

If the engine tends to reduce its speed, the gear wheel pump 5 slows down whereby its delivery to the conduit 7 and the pressure of the liquid on the diaphragm 19 decrease, with the result that the spring 20 extends and pushes the regulating rack 2 towards the left. Thus, more fuel is fed to the injection nozzles so as to counteract the decrease of speed.

The levers 14, 21 and the spring 20 perform a special function through the intermediary of the sleeve 17. If the lever 21 is swung towards the left into the position A of Fig. 1, the cam 12 recedes so far that the spring 11 can completely close the throttle passage 9, 10. Simultaneously, the cam surface 12a acts on the cam surface 47 of lever 14 to shift the latter and the sleeve 17 to their extreme right hand positions (see Figs. 6 and 8). The stop 17a cooperates with the flange 2a on the right hand end of regulating rod 2, and either shifts this rod towards its stop position, or, if the rod 2 happens to be in a position near its stop position, stop 17a positively limits the movement of rod 2 towards the left, even after the pressure in conduit 7 has fallen off. In this case, the maximum speed of the engine is narrowly limited and the injection pump control rod is free to assume its stop position.

If the lever 21 is swung into the intermediate position C, the fork 15 and sleeve 17 are shifted towards the left into the position shown in Fig. 1. In this case, the regulating rod 2 may move towards the left into its full load position.

A throttle device with stepped action, as shown for example in Fig. 2, may be used instead of the valve 8. As shown in Fig. 2, a short sleeve 23 is fixed at the point where the feed conduit 3 branches off from the pressure conduit 7. A sliding sleeve 26 is provided in the fixed sleeve 23, and is under the influence of spring 11 and cam 12. Passages 27 are arranged in the sleeve 26 in a line extending parallel to the axis of the sleeve and the edge 4a of the fixed sleeve 23 serves as control edge. The more passages 27 are rendered inoperative, the less liquid can pass into the conduit 3. The pressure in the conduit 7 in front of the diaphragm will become correspondingly greater and the regulating rod 2 will be moved further towards its stop position.

Without departing from the scope of the invention, the throttle device can be dispensed with, if a piston is used instead of the diaphragm. This piston is constructed as throttle element. Such a form of construction is illustrated in Figs. 3 to 5. As shown in Fig. 3, the gear wheel pump 5 delivers into a pressure conduit 28 leading into a cylindrical space 29. In this space a filter 30 is fitted and within this filter a sleeve 31 is arranged in which a piston 34 loaded by a spring 33 is slidable. The piston 34 is connected with the regulating rod 2 of the injection pump and has in its bottom a throttle passage 35 into which a needle 36 projects. The needle 36 is suspended between two buffer springs 37, 38 and can be set by hand or foot through an arrangement not shown in the drawings. The space 39 behind the piston 34 communicates with the feed conduit 3.

The device shown in Fig. 3 operates in the following manner:

If the engine rotates at medium speed, the gear wheel pump delivers a medium quantity of fuel into the conduit 28 which passes through the filter 30 into the cylindrical space 29 in front of the piston 34. The liquid pressure occuring at this point forces the piston towards the left, thereby compressing the spring 33 and opening the throttle 35, 36. The fuel passes through the throttle opening 35 into the space 39, and from there into the conduit 3. The more liquid the pump 5 delivers to the space 29, the greater will be the pressure acting on the piston 34 from the space 29. The narrower the throttle passage 35 is, the greater will be the pressure in the space 29 in front of the piston 34. Thus a cycle of forces is produced between the pressure of the liquid and the pressure of the spring which is dependent upon the fuel consumption, the quantity fed by the pump, the speed of the engine and the adjustment of the needle 36. In this embodiment, the position of the piston 34 towards the left corresponds to the stop position and that towards the right to the full load position of the regulating rod 2.

If the engine tends to rotate quicker, the quantity conveyed by the pump 5 to the conduit 28 increases, and the greater quantity of fuel forces the piston 34 further towards the left because it requires a greater passage aperture 35 at the needle 36. This movement continues until the cross-section of the throttle passage between 35 and 36 has become so large that no further displacement of the piston 34 relative to the needle 36 is effected even at maximum engine speed. The piston in yielding towards the left shifts the regulating rod 2 towards its stop position with the result that an increase in speed is prevented.

If the engine has a tendency to run slower, the quantity conveyed by the pump 5 decreases, and the smaller quantity of fuel in the conduit 28 and in the space 29 requires a smaller passage cross-section 35. Consequently, the spring 33 can shift the piston 34 towards the right and towards the needle 36, the regulating rod 2 being moved in the same direction. This movement

continues until the throttling effect at 35—36 becomes so strong, that the spring 33 is no longer capable of overcoming the pressure produced on the left hand side of piston 34 at minimum speed of the engine. Thus, the regulating rod 2 approaches its full load position for the pump and prevents a decrease in speed.

The arbitrary regulation of the motor speed is effected in this form of construction by an axial displacement of the control needle 36. A movement of the needle towards the right causes an acceleration and a movement of the needle towards the left causes a slowing down of the engines, because the piston 34 follows the needle position at a constant average distance defining the mean aperture 35 left between the piston 34 and the needle 36. For arresting the pump, the needle 36 may carry a stop collar 40 adapted for positive cooperation with the outer surface of the piston 34.

After passing the throttle 35, 36, the fuel flows into the space 39 either directly or through another filter which may be provided, but is not shown in the drawings. A pressure valve, not shown in the drawings, is preferably provided at the end of the conduit 3 to ensure a good filling of the latter.

As in the example shown in Fig. 1, the throttle, in this form of construction, may also be made either stepless, or means may be provided which effect a stepped regulation. Thus, for example in Fig. 4, the control piston 34 for the regulating rod 2 has a collar 41 with a series of bores 42 arranged along a helical line. According to whether these bores are more or less exposed by the needle 36 the throttle action will be greater or smaller. In Fig. 5, a sleeve 45 with throttle bores 44 is provided instead of the needle 36, the outer surface of the piston 34 forming the control edge. The quicker the engine rotates, the greater will be the output of the gear wheel pump 5 and the pressure of the liquid acting on the piston 34. The farther the piston 34 is shifted towards the left and the regulating rod 2 is moved towards its stop position, or the more passages 44 are exposed, the less will be the throttling effect of the sleeve 45.

As already mentioned, the lever 21 can be actuated by hand or foot. This lever may, however, also be connected with some other regulating arrangement which is dependent upon some function of the internal combustion engine, so that the control mechanism described and illustrated operates automatically. For instance, it would be possible to provide a thermostat, which influences the control mechanism, or the produced moment of rotation may be used for this purpose. In the case of aeroplanes, the air pressure may be made use of to actuate the control mechanism.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:

1. A fuel injection device for a combustion engine, comprising an injection pump, a fuel feed device, a pressure conduit leading from said fuel feed device to said injection pump, an adjustable throttling member in said conduit, control means for said throttling member, means for regulating the output of said injection pump, a movable pressure responsive device exposed to the pressure prevailing in the part of said pressure conduit between said fuel feed device and said throttling member to change its position as said pressure varies, said pressure responsive device being connected with said regulating means to shift the latter towards stop position when said pressure increases and towards full-load position when said pressure decreases, and stop means operatively connected with said control means to limit the movement of said regulating means in at least one direction in dependence upon the adjusted position of said control means.

2. A fuel injection device for a combustion engine, comprising an injection pump, an engine driven fuel feed pump, a pressure conduit leading from said fuel feed pump to said injection pump, a throttle device in said conduit including a stationary valve element and a movable valve element, a valve stem on said movable valve element projecting from said pressure conduit, a spring urging said movable valve element into closed position relative to said fixed valve element, an adjustable cam arranged for cooperation with the free end of said valve stem to displace said movable valve element against the action of said spring for opening said throttle device, shiftable means regulating the output of said injection pump, a movable pressure responsive device exposed to the pressure prevailing in the part of said pressure conduit between said fuel feed pump and said throttle device to change its position as said pressure varies, said pressure responsive device being connected with said regulating means to shift the latter towards stop position when said pressure increases and towards full-load position when said pressure decreases, and stop means controlled by a part of said cam to limit the movement of said regulating means in at least one direction in dependence upon the adjusted position of said cam.

3. A fuel injection device for a combustion engine, comprising an injection pump, an engine driven fuel feed pump, a pressure conduit leading from said fuel feed pump to said injection pump, a movable spring-biased piston in said pressure conduit, said piston being provided with a throttling passage, an adjustable throttling member disposed in the part of said pressure conduit between said fuel feed pump and piston and movable in the direction of the movement of the latter for cooperation with said throttling passage, and means for regulating the output of said injection pump and being connected with said piston to be shifted towards stop position when the pressure acting on said piston increases and towards full-load position when said pressure decreases.

4. A fuel injection device for a combustion engine, comprising an injection pump, an engine driven fuel feed pump, a pressure conduit leading from said fuel feed pump to said injection pump, an adjustable throttling member in said conduit, control means for said throttling member, means for regulating the output of said injection pump, a movable spring-biased element having one face thereof exposed to the pressure prevailing in the part of said pressure conduit between said fuel feed pump and said throttling member to change its position as said pressure varies, said spring-biased element being connected with said regulating means to shift the latter towards stop position when said pressure increases and towards full-load position when said pressure decreases, and stop means operatively connected with said control means to limit the movements of said regulating means in at

least one direction in dependence upon the adjusted position of said control means.

5. A fuel injection device for a combustion engine, comprising an injection pump, an engine driven fuel feed pump, a pressure conduit leading from said fuel feed pump to said injection pump, a throttle device in said conduit including a stationary valve element and a movable valve element, a valve stem on said movable valve element projecting from said pressure conduit, a spring urging said movable valve element into closed position relative to said fixed valve element, an adjustable cam arranged for cooperation with the free end of said valve stem to displace said movable valve element against the action of said spring for opening said throttle device, means for regulating the output of said injection pump, a movable spring-biassed element having one face thereof exposed to the pressure prevailing in the part of said pressure conduit between said fuel feed pump and said throttle device to change its position as said pressure varies, said spring-biassed element being connected with said regulating means to shift the latter towards stop position when said pressure increases and towards full-load position when said pressure decreases, a lever controlled by a portion of said cam, and a movable stop controlled by said lever to limit the movements of said regulating means in at least one direction in dependence upon the adjusted position of said cam.

6. A fuel injection device for a combustion engine, comprising an injection pump, an engine driven fuel feed pump, a pressure conduit leading from said fuel feed pump to said injection pump, a movable spring-biassed piston in said pressure conduit, said piston being provided with a throttling passage, an adjustable throttling member disposed in the part of said pressure conduit between said fuel feed pump and piston and movable in the direction of the movement of the latter for cooperation with the passage in the latter, means for regulating the output of said injection pump and being connected with said piston to be shifted towards stop position when the pressure acting on said piston increases and towards full-load position when said pressure decreases, and an abutment on said throttling member for cooperation with said piston to permit positive shifting of the piston and of said regulating means towards the stop position of the latter by a corresponding adjustment of said throttling member.

7. A fuel injection device, as claimed in claim 1, in which said stop means is controlled by said control means to change its position when the throttle member is in the neighbourhood of its closed throttle position and to remain stationary during the remainder of the throttle movements.

8. A fuel injection device for a combustion engine comprising an injection pump, a fuel feed device, a pressure conduit leading from said fuel feed device to said injection pump, a movable member regulating the output of said injection pump, a movable pressure responsive device exposed to the pressure prevailing in a part of said pressure conduit and adapted to change its position as said pressure varies, said pressure responsive device being connected with said regulating member to shift the latter towards stop position when said pressure increases and towards full-load position when said pressure decreases, operator controlled means to vary the pressure in said part of the pressure conduit, and an adjustable element controlled by said pressure varying means to positively limit in each adjusted position thereof the pressure controlled movements of said regulating member in at least one direction in dependence upon the adjusted position of said element.

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