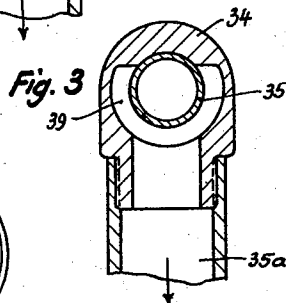
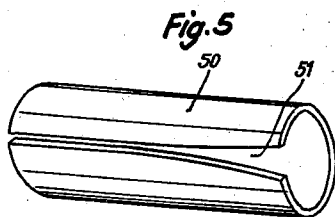
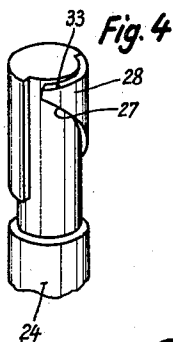
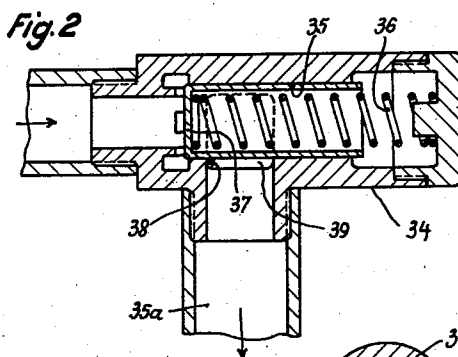
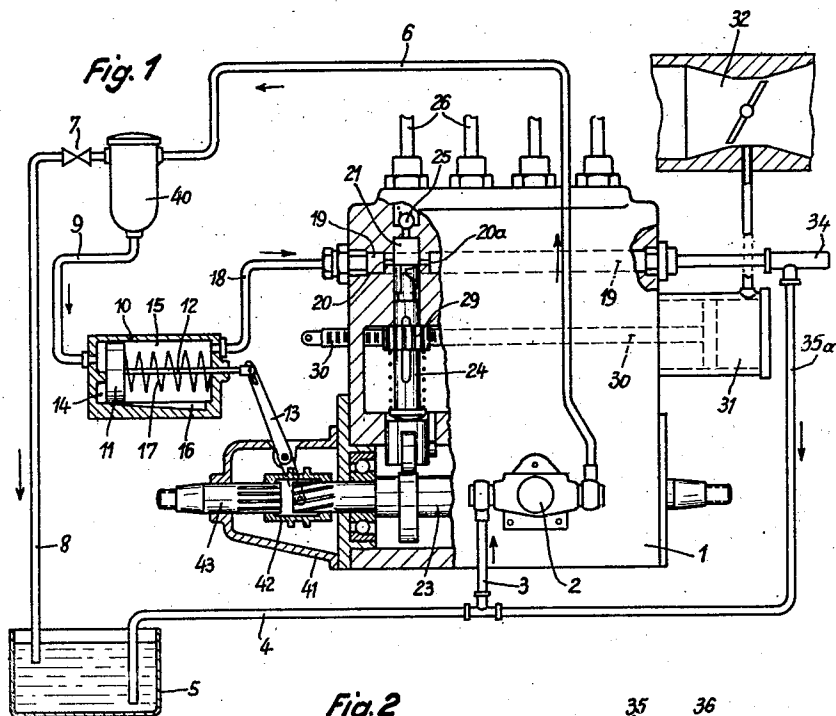


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W. VOIT
FUEL INJECTION APPARATUS FOR DIESEL AND OTHER
INTERNAL COMBUSTION ENGINES
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Inventor
Willi Voit
by Roy F. Stussard
his attorney

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FUEL INJECTION APPARATUS FOR DIESEL
AND OTHER INTERNAL COMBUSTION
ENGINESWilli Volt, Stuttgart-Bad Cannstatt, Germany,
assignor to Robert Bosch Gesellschaft mit be-
schränkter Haftung, Stuttgart, GermanyApplication March 21, 1939, Serial No. 263,230
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6 Claims. (Cl. 123—139)

The present invention relates to fuel injection apparatus for Diesel and other internal combustion engines of the type wherein an injection pump is associated with an hydraulic adjusting means for varying the injection timing in response to variations in the delivery of fluid to said hydraulic adjusting means by a pumping means, the delivery of which increases with increase in engine speed, which hydraulic adjusting means is so constructed that different rates of flow of fluid past the displaceable member of said hydraulic adjusting means are obtained in different positions of said member.

The invention has for its object to obtain a smooth working of the hydraulic adjusting member in fuel-injection apparatus of this kind, and more particularly to prevent fluctuations of load on the engine from influencing the said member.

According to the present invention, in apparatus of the type set forth an overflow valve is connected by a conduit to the inlet chamber of the injection pump, whereby the fluid pressure obtaining within said conduit remains substantially constant and independent of the amount of fuel injected.

The invention is more particularly described with reference to the accompanying drawing, which shows in Figs. 1 to 5 forms of construction by way of example, and in which:

Figure 1 is a general arrangement of a fuel injection apparatus with certain parts shown in section.

Figure 2 is a longitudinal section through the overflow-valve.

Figure 3 is a cross-section through the overflow valve on the line III—III in Figure 1.

Figure 4 shows a detail on an enlarged scale.

Figure 5 shows a detail for another form of construction.

In the drawing, an injection pump 1 is driven from an internal combustion engine in a manner not shown. A fuel feed-pump 2, which is attached to the injection pump, is driven by it. The fuel is drawn from a container 5 through the suction pipe 3, 4, of the feed pump. A pressure pipe 6 leads from the feed-pump 2 to a filter 40, that is connected on the one hand by a valve 7 and a pipe 8 to the container 5, and on the other hand by a pipe 9 to a cylinder 10.

A piston 11 is guided in the cylinder 10, and is connected by a piston-rod 12 to a lever 13. The piston 11 divides the interior of the cylinder 10 into two chambers 14 and 15, which are connected together merely by a slot 16 formed in the cylinder wall. The cross section of the slot

16 increases from one end of the cylinder to the other end. In the chamber 15 a spring 17 is arranged, which tends to force the piston to the left in Figure 1.

From the chamber 15 a pipe 18 leads into the inlet chamber 19 of the injection pump, from which the fuel passes in known manner through inlet passages 20 into the cylinder chambers 21 of the injection pump 1. At each revolution of the cam-shaft 22 of the injection pump its pump pistons 24 are moved once up and down. As soon, at each upward stroke, as the inlet passage 20 and the return flow passage 20a situated opposite thereto are closed by the pump piston, the fuel enclosed in the cylinder chamber is compressed and forced through pressure valves 25 and pipes 26 to the injection nozzles (not shown) of the internal combustion engine. The feed to the nozzles ceases as soon as the controlling face 28 of the piston, provided with an oblique controlling edge 27, begins to uncover the return flow passage 20a. This opening takes place even during the upstroke, and in fact in dependence on the length of that part of the controlling face 28 which is opposed to the return flow passages 20a by the turning of the piston. The turning or angular movement of the piston is effected by a spur-wheel 29, which is secured to the piston so as to be longitudinally displaceable, and can be rotated by a toothed controlling bar 30. In the example of construction, the controlling bar 30, mounted so as to be longitudinally displaceable in the casing of the injection pump, is operated by a pneumatic governor 31, which responds to the induction air conditions in the induction pipe 32 of the engine that vary in dependence on the engine-speed and on the position of a throttle-valve adjustable at will by the driver.

Just as the end of the effective pumping stroke of the injection pump is varied by the lower oblique edge 27 of the controlling face 28 on the rotating of the pump piston, so the beginning of the pumping, that is, the beginning of the injection, can be determined by its upper oblique edge 33. The oblique edge 33 is so formed in the example of construction shown in Figure 4, that with the adjustment for larger injection amounts as the load on the engine increases, the beginning of the injection is somewhat advanced. In this case the slope of the edge 33 is determined according to whether, and in some cases to what extent, in the internal combustion engine in question for which the injection pump is in-

tended, an advance of the beginning of the injection in dependence on the load is desired.

The inlet chamber 19 of the injection pump is connected through an overflow valve 34 to a pipe 35a, through which the fuel delivered in excess can flow back on the suction side to the feed pump 2, or into the fuel container 5. The valve 34, as shown in Figures 2 and 3, contains a hollow piston-valve 35. A spring 36 tends to press the face 37 of this valve against a seat. This spring is of comparatively small strength so that the valve 35 is moved to the right in Figure 2, even on a small excess pressure in the inlet chamber 19, for example at 3 lbs. per square inch above atmospheric pressure. In this case as soon as the front edge 37 of the valve has reached the opening edge 38 in the valve body, a larger passage cross-section 39 is opened, so that the pressure in the inlet chamber can then not rise above the maximum pressure determined by the pressure of the spring 36, if suddenly large quantities are to flow away, (high speed running of the valve—with a small load).

In a valve having a passage cross-section that slowly opens, a rise in pressure could in this case take place in the inlet chamber. The valve 34 in the construction according to Figures 2 and 3 is thus particularly well adapted for adjusting a maximum pressure in the inlet chamber which is not to be exceeded.

The lever 13 is pivotally mounted in a part 41 of the casing of the injection pump 1, and with its lower arm engages in fork fashion with a coupling sleeve 42 which engages with internal teeth in external teeth provided at the end of a shaft 43, coupled to the internal combustion engine, and at the adjacent end of the cam-shaft 23. The teeth on the end of the cam-shaft and on the right hand part of the sleeve 42 are made as oblique teeth and have such a direction that on the displacement of the sleeve to the left in Figure 1, the cam-shaft is rotated somewhat in its running direction, so that thereby a corresponding advance of the injection stroke is produced.

When the engine is running at low speed, the feed-pump 2 coupled to it delivers comparatively little fuel in a particular unit of time, and the fuel passes through the pipe 6, the filter 40 and the pipe 9 into the chamber 14. The valve 7, which has a comparatively strong initial pressure, for example an opening pressure of 15 lbs. per sq. in. higher than atmospheric pressure, remains closed. The pressure occurring in the chamber 14 is in this case so small that the piston 11 cannot be displaced to the right against the pressure of the spring 17. The small cross section of the groove 16 at its left end suffices, however, to permit the comparatively small amount of fuel to pass into the chamber 15 without an appreciable increase in pressure in the chamber 14, and also to fill the inlet chamber 19 up to the maximum pressure adjusted by the overflow valve 34, when the injection pump, owing to the greater load on the engine, has a high fuel consumption. If now at the assumed lower speed the load on the engine decreases, and thus the amount of fuel consumed by the injection pump in a unit of time also decreases, an amount of fuel increased by this reduced consumption simply flows away through the overflow valve 34; in this case, however, nothing is altered in the position of the piston 11, as owing to the speed of the feed-pump 2 remaining the same, always the same delivery amount is

pumped in the unit of time through the narrow passage cross section in the narrow part of the groove 16.

As the speed increases, however, the larger amount of fuel pumped by the feed-pump 2 in the unit of time can no longer pass through the narrow part of the groove 16 without a rise in pressure in the chamber 14. The increase in pressure that occurs displaces the piston 11 so far to the right in Figure 1 against the action of the spring 17, until a broader passage cross-section of the groove 16 to correspond to the higher speed is adjusted. The movement of the piston 11 to the right becomes so much the greater as the width of the groove increases, the higher the speed of the engine rises. As now the piston 11 serving as the adjusting member, and bathed by liquid, is connected in the way above described to the injection-adjusting lever 13, the time of the injection is thus advanced corresponding to the increase in speed. Whether with the then prevailing speed, the load on the engine and the injection amount are large or small, plays no part in the movement of the piston 11, as the overflow valve 35 suppresses all fluctuations in pressure in the inlet chamber 19 that may be caused by fluctuations in load and fuel requirement. The piston 11 working in the cylinder 10 thus responds, owing to the action of the overflow valve 34, simply to alterations in speed, but not to alterations in load. The adjusting device thus alters the beginning of the injection purely in dependence on speed. This arrangement for adjusting the injection which is dependent purely on speed, is therefore applicable to a multitude of different types of engines, and in fact independent of whether in the particular case an injection adjustment varying with the load is necessary or not.

Instead of the groove 16 formed in the surface of the cylinder 10, a smooth cylinder having an inserted bush 50 (Figure 5) which is provided with a slot 51 which becomes broader from one end to the other, could also be employed. In case the alteration of the delivery amount of the pump 2 and the adjusting movement of the lever 13 do not coincide at a certain range or at the whole range of speeds, so that at each speed the correct adjustment of the beginning of the injection is effected, the adjustment can be corrected by suitable alterations in the cross-section of the slot 51. Instead of the feed-pump 2 which serves for pumping the fuel to the inlet chamber 19 of the injection pump, another pump may also be employed, which in dependence on the engine speed pumps a liquid medium into the cylinder 10 and from there to an overflow valve 34 adjusted to a definite pressure.

I declare, that, what I claim is:

1. In a hydraulic governing system for an internal combustion engine having an injection pump, said pump having an inlet chamber, driving means for driving said pump from said engine, and a fuel supply pump, driven by said engine, for supplying fuel to said inlet chamber and whose delivery increases with increase of engine speed, the combination of an hydraulic adjuster to which fuel is fed by said supply pump and which in response to variations in the feed of fuel from said supply pump varies the timed relationship between said injection pump and its driving means, said adjuster comprising a cylinder, a piston disposed in said cylinder and a restricted by-pass in said cylinder whereby a quantity of fuel passes said piston and said

quantity varies with variation of the piston's position, an overflow valve, conduit connecting said valve to the injection pump inlet chamber whereby the fluid pressure obtaining within said conduit and inlet chamber remains substantially constant and independent of the amount of fuel injected, and a second conduit connecting the inlet chamber of the injection pump with the hydraulic adjuster, for leading fuel to the inlet chamber.

2. In a hydraulic governing system for an internal combustion engine having an injection pump, said pump having an inlet chamber, driving means for driving said pump from said engine, and a fuel supply pump, driven by said engine, for supplying fuel to said inlet chamber and whose delivery increases with increase of engine speed, the combination of an hydraulic adjuster to which fuel is fed by said supply pump and which in response to variations in the feed of fuel from said supply pump varies the timed relationship between said injection pump and its driving means, said adjuster comprising a cylinder provided with a longitudinal conduit in the form of a tapered groove in the wall of said cylinder and a piston disposed therein whereby fuel may flow past the piston at a rate dependent upon the longitudinal position of the piston within the cylinder, an overflow valve, a conduit connecting said valve to the injection pump inlet chamber whereby the fluid pressure obtaining within said conduit and inlet chamber remains substantially constant and independent of the amount of fuel injected, and a second conduit connecting the inlet chamber of the injection pump with the hydraulic adjuster, for leading fuel to the inlet chamber.

3. In a hydraulic governing system for an internal combustion engine having an injection pump, said pump having an inlet chamber, driving means for driving said pump from said engine, and a fuel supply pump, driven by said engine, for supplying fuel to said inlet chamber and whose delivery increases with increase of engine speed, the combination of an hydraulic adjuster to which fuel is fed by said supply pump and which in response to variations in the feed of fuel from said supply pump varies the timed relationship between said injection pump and its driving means, said adjuster comprising a cylinder provided with a longitudinal conduit in the form of a tapered groove in the wall of said cylinder and a piston disposed therein whereby fuel may flow past the piston at a rate dependent upon the longitudinal position of the piston within the cylinder, an overflow valve comprising a piston valve which permits of a large flow on being displaced by a stroke which is small relative to the bore of said piston,

a conduit connecting said valve to the injection pump inlet chamber whereby the fluid pressure obtaining within said conduit and inlet chamber remains substantially constant and independent of the amount of fuel injected, and a second conduit connecting the inlet chamber of the injection pump with the hydraulic adjuster, for leading fuel to the inlet chamber.

4. In a hydraulic governing system for an internal combustion engine having means for periodically supplying motive fluid to the engine cylinders in timed relation to the engine crank shaft, a source of motive fluid, conduit means connecting said source and said motive fluid supplying means, and means for circulating motive fluid in said conduit means from said source to said motive fluid supplying means and back to said source at a rate varying as a function of the speed of said engine whereby motive fluid is delivered to said motive fluid supplying means in excess of its requirements and excess motive fluid is returned to said source, the combination of control means arranged in said conduit means and receiving motive fluid from said circulating means and delivering it to said motive fluid supply means, said control means including a cylinder through which motive fluid flows from said circulating means, a movable piston in said cylinder to permit flow of motive fluid past said piston from end to end of said cylinder but said piston interposing a resistance to said flow whereby said piston will be movable by and responsive to variations in the rate of flow of such motive fluid, means responsive to movement of said piston for effecting changes in the time of the motive fluid supply period, and an overflow valve in said conduit means between said control means and said source for maintaining the fluid pressure at the outlet of said cylinder substantially constant whereby both sides of said piston are immersed in motive fluid, one side being subject to fluid under variable pressure directly from said circulating means and the other side subject to fluid under substantially constant pressure.

5. In a hydraulic governing system as set out in claim 4 in which the restricted by-pass means comprises a groove formed in the interior wall of said cylinder and extending longitudinally from end to end thereof, said groove gradually increasing in cross-section from end to end.

6. In a hydraulic governing system as set out in claim 4 in which the over-flow valve comprises a piston valve which permits of a large flow of fluid upon being displaced under pressure of said fluid by a stroke which is small relative to the diameter of said piston.

WILLI VOIT.