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TIMING OF FUEL INJECTION PUMPS

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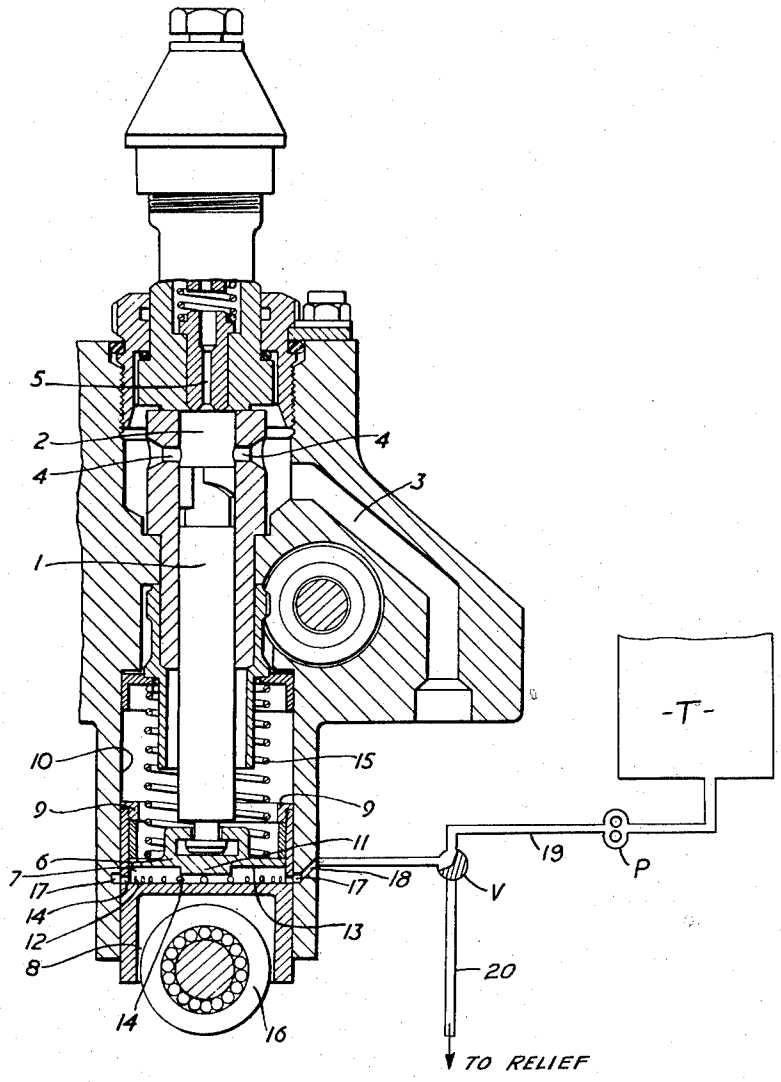

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TIMING OF FUEL INJECTION PUMPS

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This invention relates to "spill" type fuel injection pumps for internal combustion engines, and it is an object of the invention to enable the timing of the fuel delivery from such pumps to be varied while the engine, and therefore the pump, is running.

"Spill" type fuel pumps are well known in themselves. In general they comprise a plunger reciprocating in a pump chamber, the plunger and the chamber being provided with cooperating ports spaced in the direction of movement of the plunger, such that at one point in the stroke of the plunger, the fuel inlet to the chamber is closed, and the plunger starts to deliver fuel from the chamber to the engine at high pressure, while at a following point in the stroke of the plunger the fuel inlet, or some other relief port, is opened, thus ending the effective stroke of the plunger and stopping the fuel delivery to the engine, by allowing the excess fuel in the chamber to "spill" out. In such pumps the quantity of fuel injected at each stroke of the plunger is normally controlled by varying the displacement between the controlling edges of the cooperating ports.

Now according to the present invention in a method of advancing or retarding the fuel injection timing of a direct fuel injection type internal combustion engine having a spill type injection pump associated therewith, the mean position of the stroke of the plunger of the pump is altered in relation to the pump chamber.

It will be appreciated that it is unnecessary to alter the timing of the actual stroke of the plunger, since by altering the mean position of the stroke, the effective stroke, and hence the fuel delivery timing is automatically advanced or retarded.

According to a preferred feature of the present invention, hydraulic liquid is supplied under pressure to a hydraulic piston and cylinder assembly mounted between the plunger and the plunger operating mechanism to cause the plunger to operate in a part of the plunger chamber remote from the plunger operating mechanism when the fuel injection timing is advanced, and in a portion of the plunger chamber adjacent to the plunger operating mechanism when the supply of pressure liquid is cut off and the fuel injection timing is retarded.

Preferably the hydraulic liquid is supplied to the piston and cylinder assembly at a point in the stroke of the plunger, when it is not effectively pumping fuel under high pressure.

Thus according to another aspect of the invention a fuel injection pump of the "spill" type includes means for varying the mean position of the stroke of the plunger of the pump in relation to the chamber in which the plunger operates, without altering the length of stroke of the plunger.

In a preferred construction the means for varying the mean position of the stroke of the plunger comprises a hydraulic piston and cylinder assembly, one side of which is connected to the stem of the plunger, and the other side to the plunger operating mechanism. Hydraulic

liquid is preferably supplied to the hydraulic cylinder through a port or ports in a stationary member which cooperates with a moving part of the piston and cylinder assembly to deliver the liquid automatically at a predetermined point in the stroke of the plunger.

According to another preferred feature the supply ports are positioned so as to supply liquid to the cylinder when the plunger is near its bottom dead centre position and to close the outlet from the cylinder before the plunger starts its effective pumping stroke.

Thus in a preferred construction one side of the piston and cylinder assembly is directly connected to the plunger and the other side is arranged to bear against the plunger operating mechanism, the whole being free to reciprocate within a fixed bore with movement of the plunger, and a port or ports are provided in the wall of the said bore through which hydraulic liquid can be supplied to the piston and cylinder assembly.

The invention may be performed in various ways but one example will now be described with reference to the accompanying drawing which shows a cross section through part of a spill type fuel pump embodying a construction for carrying the invention into practice.

As shown in the drawing the pump comprises a plunger **1** and pumping chamber **2** which draws fuel from an inlet passage **3** through inlet ports **4** and delivers the fuel under high pressure through a discharge passage **5**. As the above construction is well known in itself and forms no part of the present invention it will not be described in detail. The lower end of the plunger **1** is connected to a piston **6** arranged to have a limited movement within the bore **7** of a hollow cylindrical tappet **8**, upward movement of the piston **6** being limited by means of a retaining ring **9** screw-threaded into the upper end of the bore **7** of the tappet **8**. The tappet in turn slides within a cylinder **10** formed in the main body of the pump making a fluid tight fit with this cylinder. The under side of the piston **6** is provided with a boss **11** which engages the closed lower end **12** of the tappet bore **7** when the piston is in its lower most position within the bore and ensures that there is a gap between the end of the bore **12** and the face **13** of the piston **6**. A series of fluid inlet ports **14** are provided through the walls of the bore **7** of the tappet adjacent to the closed end **12** and communicate with the gap between the piston and the end of the bore. The piston **6** is urged downwards towards the closed end **12** of the tappet bore **7** by a compression spring **15** acting between the upper face of the piston **6** and the upper end of the cylinder **10** in which the tappet **8** reciprocates. This spring **15** also tends to maintain a cam follower **16** mounted on the lower side of the tappet **8** in contact with a plunger operating cam (not shown) which imparts a reciprocating movement to the plunger **1** through the tappet **8** and the piston **6** when the engine with which the pump is associated is running.

Formed in the inner face of the wall of the cylinder **10**, and level with the fluid inlet ports **14** in the tappet **8**, when the tappet **8** and plunger **1** are in their bottom dead centre position is an annular gallery **17** to which hydraulic liquid is supplied through a fluid delivery line **18** in the body of the pump.

In order to advance the timing whilst the engine is running hydraulic liquid is admitted to the annular gallery **17** under a sufficient pressure to overcome the force of the compression spring **15** referred to. When the tappet **8** is at its bottom dead centre position liquid flows through the fluid inlet ports **14** and into the gap between the piston **6** and the end of the bore **12** of the tappet **8**, and the piston **6** and the plunger **1** are lifted against the compression spring **15** until the retaining ring **9** on the upper end of the tappet is engaged as shown

in the drawing. The plunger 1 in this way is moved upwards relative to the pumping chamber 2 of the pump. Further rotation of the plunger operating cam lifts the tappet 8 which moves the fluid inlet ports 14 clear of the annular gallery 17 and thus closes the ports "locking" the oil within the part of the bore 7 of the tappet enclosed between the lower face 13 of the piston 6 and the end of the bore 12. This occurs before the plunger 1 has closed the fuel inlet port 4 into the pumping chamber 2, and before the effective stroke of the plunger has started. Thus it will be seen that the pressure of the hydraulic fluid supplied to the tappet need only be relatively low. When the plunger 1 and tappet 8 return to their bottom dead centre positions the fluid inlet ports 14 are again opened and any loss of hydraulic liquid from the bore 7 in the tappet is thus replaced.

To retard the timing, the liquid supply is cut off remote from the fluid delivery line 18, and the annular gallery 17 is opened to relief. For this purpose there is illustrated diagrammatically in the drawing a supply line 19 establishing communication between a liquid supply source or tank T and the line or passage 18, the fluid being delivered under pressure by a conventional pump P under the control of a two-way valve V which is operable to cause delivery of the pressurized hydraulic fluid from the line 19 to the line 18, or, alternatively, to a relief line 20. At bottom dead centre therefore the compression spring 15 acts on the piston 6 to expel the oil from the tappet bore 7 through the fluid delivery ports 14 and the annular gallery 17 and return the piston boss 11 into contact with the end of the bore 12 in the tappet 8. The plunger 1 thus moves downwards in relation to the fuel inlet port 4 in the pumping chamber 2, the mean position of the plunger stroke being moved accordingly, so retarding the timing of the effective stroke of the pump. When the timing is retarded in this way the position of the plunger 1 at top dead centre is also lowered in relation to the pumping chamber ports thus reducing the available maximum effective stroke of the pump after closure of the fuel inlet port. This reduces the maximum obtainable fuel delivery of the pump, but this can usually be tolerated as it only occurs in the retarded condition when the engine speed and power output is usually low.

It will be apparent that the quantity of fuel delivered, being a function only of effective pump stroke from port "cut-off" to port "spill" in this type of "spill" pump is independent of injection timing variation by this apparatus.

What I claim as my invention and desire to secure by Letters Patent is:

1. A fuel injection pump of the "spill" type for use with an internal combustion engine said fuel injection pump having a pump chamber and a plunger arranged to reciprocate therein including a plunger control device to vary the mean position of the stroke of the said plunger in relation to the said pump chamber without altering the length of the stroke of the plunger, said means for varying the mean position of the stroke of the plunger comprising a hydraulic piston and cylinder assembly, one side of which is connected to the stem of the plunger, and the other side of which is connected to the plunger operating mechanism, said assembly being disposed with the common cylindrical axes of said cylinder and said piston extending between the said plunger stem and the said operating mechanism, whereby admission or exhaust of hydraulic fluid to or from said cylinder will change the axial length of said assembly.

2. A fuel injection pump as claimed in claim 1 including a stationary member associated with the said piston and cylinder assembly and having at least one hydraulic liquid supply port through which hydraulic liquid can be supplied, said supply port coming into communication with the hydraulic chamber of the piston and cylinder assembly at a predetermined point in the stroke of the plunger.

3. A fuel injection pump as claimed in claim 2 in which the said supply port or ports are positioned so as to supply liquid to the said piston and cylinder assembly when the plunger is near its bottom dead centre position and to seal the said liquid in said piston and cylinder assembly before the plunger starts its effective pumping stroke.

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