A fuel injection pump is provided with timing control in which a hollow cap removably mounted in a bore of the fuel pump forms a pressure chamber in which the advance piston is axially movable for controlling the timing of injection. An annulus around the cap provides a passage for the delivery of pressurized fuel to the pressure chamber and a flat reed valve in the pressure chamber overlying the inlet port of the pressure chamber isolates the ring seals for sealing the annulus from the repetitive high pressure pulses imposed when the pumping plungers move past the cam lobes during pumping strokes which otherwise may cause the seals to be extruded into the clearance gap between the cap and the bore.
This invention relates to fuel pumps of the type utilized for the delivery of fuel to compression-ignition engines, and more particularly to the means for automatically varying the timing of the pump in response to engine operating conditions. The device of this invention is an improvement upon that disclosed and claimed in U.S. Pat. No. 2,660,992 dated Dec. 1, 1953.

Engine fuel pumps of the character referred to above deliver metered charges of liquid fuel under high pressure in sequence to the several cylinders of an associated engine in timed relationship therewith. A cam ring of the pump having inwardly directed cam lobes surrounds one or more pump plungers which produce the high pressure charges of fuel so as to move the pump plungers bodily relative to the cam to translate the configuration of the cam lobes into the desired timed pumping strokes.

In order to increase efficiency and smoothness of operation of the engine, it is desirable to advance the timing of injection of fuel into the cylinders at increased engine speeds. This may be accomplished by adjusting the angular position of the cam which is mounted for limited angular movement and is restrained from rotating by an advance piston and a connecting pin. The high pressure generated within the pump chamber may reach a level as high as, say, 10,000 p.s.i. to impose on the advance piston repetitive high stress shock loading. Since the position of the advance piston is controlled hydraulically, it is readily apparent that the seals used for confining the hydraulic fluid controlling the advance piston are subjected to extremely high stresses and it is an object of this invention to provide an arrangement whereby these seals are protected from damage from such stresses.

Another aim of this invention is to provide an improved timing advance mechanism of the type referred to having increased durability and which is simple and economical to fabricate and assemble.

Other objects will be in part obvious and in part pointed out more in detail hereinafter.

A better understanding of the invention will be obtained from the following detailed description and the accompanying drawing of an illustrative application of the invention.

In the drawing:

FIG. 1 is a simplified schematic view of a fuel pump of the type involved in the present invention;
FIG. 2 is a fragmentary end view of an automatic timing mechanism of the prior art;
FIG. 3 is a cross-sectional view of the timing mechanism incorporated in the present invention; and
FIG. 4 is an elevational view of a valve used in the practice of the present invention.

Referring now to the drawing in detail, there is shown in FIG. 1 a schematic representation of a fuel pump suitable for the practice of the present invention. Fuel under pressure is delivered to the drilled passage 10 of the pump housing to an annulus 12 for delivery to a metering valve passage 14 wherein a metering valve 16 provides a variable restriction to control the flow of fuel delivered through an annulus 18 and a passage 20 to the pump chamber 22 of a high pressure pump shown as comprising reciprocable pump plungers 24 simultaneously urged inwardly by cam lobes 26 of cam ring 28. An inlet passage 19 may sequentially register with a plurality of ports (not shown) providing communication with annulus 18 when the plungers 24 are free to move outwardly. Rollers 30 engage cam lobes 26 and act through shoes 32 to force the plungers 24 inwardly to pressurize the fuel contained in the pump chamber 22 to a high pressure. The high pressure fuel from the pump chamber 22 is delivered by the passage 20 to a series of passages (not shown) positioned around the distributor rotor 34 for sequential registry with the passage 20 to deliver the charges of fuel from the pump chamber 22 to the several cylinders of the associated engine.

To vary the timing of injection of the fuel into the associated cylinders of the engine, the cam ring 28 is mounted in the pump housing for a limited angular movement to adjust the angular positions of the cam lobes 26 and is restrained from rotating by the piston 40 of the automatic advance mechanism and the connecting pin 42. As shown in FIG. 1, a chamber at one end of piston 40, which is biased to the left by a spring (not shown), receives liquid fuel through the passage 44, the ball valve 46, and the passage 48. Where the pressure in passages 10 and 44 is correlated engine speed, it is readily apparent that the pressure of the fuel acting on the piston 40 will adjust its position of equilibrium at different speeds. If desired, the passage 44 could be connected to the annulus 18 to deliver metered fuel pressure to the advance mechanism so that the axial position of piston 40 would be adjusted according to load.

As shown in FIG. 2, which depicts a prior art design, fuel from the passage 48 enters the advance piston chamber 50 to urge the advance piston to the right against the opposing force provided by spring 52 so that a position of equilibrium is reached when the force of the liquid fuel in chamber 50 equals the spring force of spring 52. Ball check 46 (FIG. 1) traps the fuel in the chamber 50 to offset the normal tendency of the cam 28 to move to a retarded position as the rollers ride over the cam lobes of the cam ring 28. An orifice 54 below the ball check 46, as well as leakage past the split metal piston ring 56 of the advance piston 40a, allows for the gradual bleeding of the fuel from the chamber 50 so that the advance piston 40a may move to the left to assume a new position of equilibrium when the pressure in passage 48 and chamber 50 decreases.

As shown in FIG. 2, the seals 60, 62 are subjected to the repetitive high intensity pulses of hydraulic pressure each time the rollers 30 ride over the cam lobes of cam 28. This has resulted in the extrusion of the resilient "O" ring seal 60 into the clearance gap between the sleeve 64 and the bore 66 in which the sleeve is threaded causing the failure of the seal. In accordance with the present invention, the seals for the advance piston assembly are safeguarded against the high pressure shock impulses imposed as the rollers 30 ride up on the cam lobes 26.

As shown in FIG. 3, fuel under pressure from passage 48 enters the annulus 49 around the cap sleeve 64a which is provided with an axial groove 68 to provide open communication with the passage 70, 72, of the cap sleeve 64a which terminates an inlet port 74 in the chamber 50. A flat annular reed valve 80 (FIG. 4) overlying port 74 within the chamber 50 and is mounted around an adjusting screw 82 by means of a pair of mounting screws 84 to provide a flat ring seal.
for accommodating one way flow of fuel into the chamber 50. Since any high impact pulses of pressure produced by the rollers riding over the cam lobes automatically seats the reed washer to trap the fluid in chamber 50 and to prevent flow into passage 72, it is readily apparent that the need for the ball check valve is eliminated and the ring seals 60, 62 are isolated from high pressure pulses imposed on the pumping action. A bleed orifice 86, as well as leakage past piston ring 56, allows for the gradual bleeding of the fuel from chamber 50 when the pressure in chamber 50 decreases to allow the piston 40a to assume a new position of equilibrium at lower engine speeds.

As shown in FIG. 3, leakage through bleed orifice 86 is returned to axial groove 68 to minimize the portion of the fuel required from annulus 12 for the operation of the advance mechanism. If desired, a bleed orifice 86a could be substituted for bleed orifice 86.

In the design as shown in FIG. 3, the advance piston bias spring 52a has one end which seats against the head of an adjusting screw 82 and another end is fixed relative to piston 40a by a split washer 88 received within a groove 90 of the advance piston. In this arrangement, the adjusting screw serves to adjust the rate of advance by adjusting the spring force to change the axial position assumed by piston 40a at equilibrium at different engine speeds. A shoulder 92 on piston 40a engages a shoulder on cap sleeve 64a to fix the maximum retard setting of the cam.

As will be apparent to persons skilled in the art, various modifications, adaptations, and variations of the foregoing specific disclosure can be made without departing from the teachings of the present invention.

I claim:

1. A fuel injection pump comprising a cam, pump plungers movable relative to the cam to translate the contour of the cam into sequential pumping strokes, a source of fluid under a pressure correlated with an operating condition of the associated engine, a bore in said pump, a removable cap forming a pressure chamber and cooperating with said bore to define a passage for the delivery of fluid to the inlet port of said pressure chamber from said source, seals interposed between said cap and said bore to prevent leakage from said passage, a piston movable in said chamber, a connector connecting the piston to the cam to control the position of the cam to advance and retard the relative timing of the pumping strokes, and a one-way valve in said pressure chamber overlying said inlet port to confine within said pressure chamber the pressure pulses resulting from the forces imposed on said cam by the pumping strokes.

2. The fuel pump of claim 1 wherein said valve is a flat reed valve.

3. The pump of claim 2 wherein mating shoulders on said cap and said piston serve as a stop to limit the movement of the piston toward said pressure chamber.

4. The pump of claim 3 wherein an adjustable biasing spring within said pressure chamber biases said piston toward the pressure chamber.

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