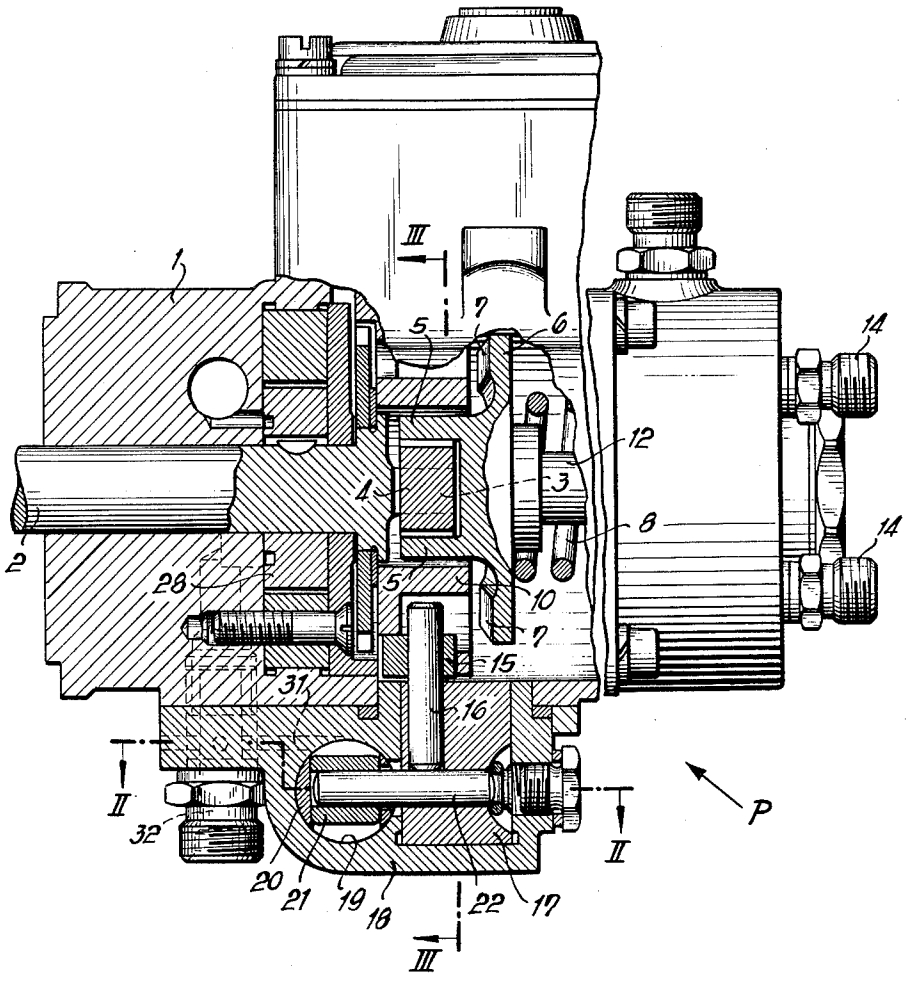
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FUEL INJECTION PUMP FOR MULTICYLINDER INTERNAL COMBUSTION ENGINES

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FIG. 1



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FIG.2

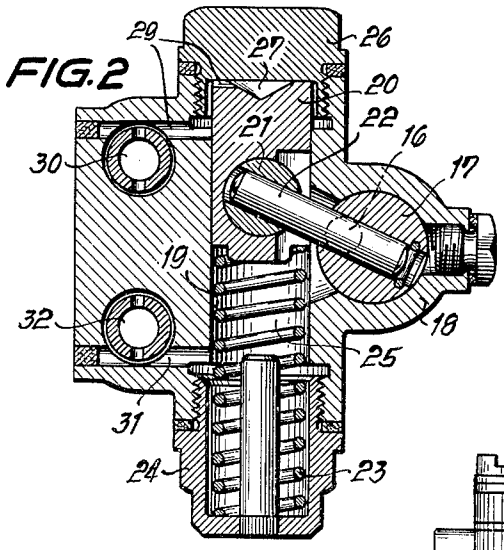
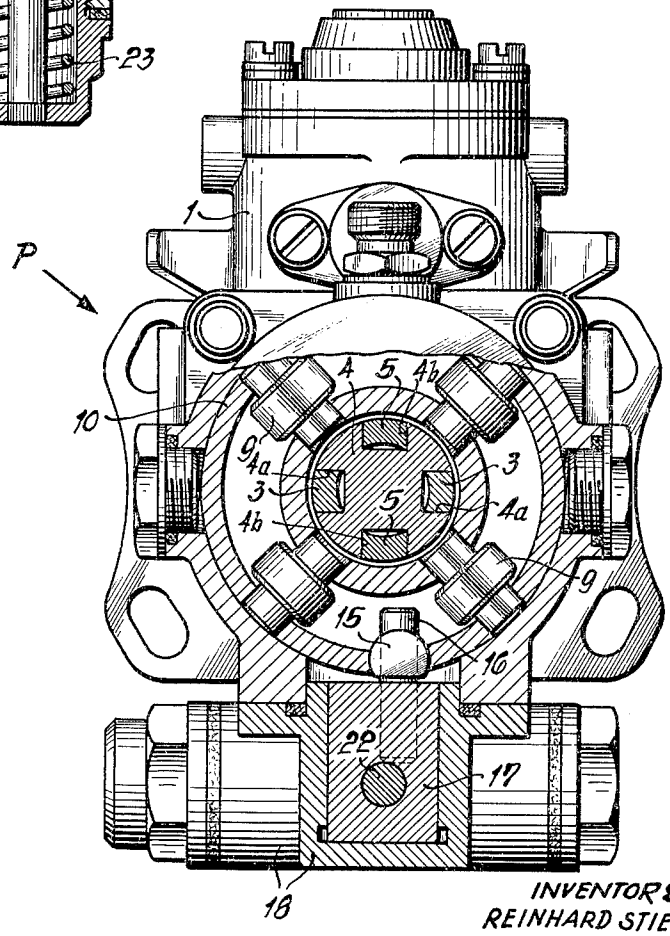


FIG.3



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FUEL INJECTION PUMP FOR MULTICYLINDER INTERNAL COMBUSTION ENGINES

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The present invention relates to fuel injection pumps for internal combustion engines, and more particularly to a distributor type fuel injection pump for multicylinder internal combustion engines.

An object of the invention is to provide a fuel injection pump which is so constructed that the exact timing of fuel injection into the cylinders of an internal combustion engine may be varied in dependency on the feed or output pressure of the fuel supply pump.

Another object of the invention is to provide a fuel injection pump of the above outlined characteristics wherein the exact timing of fuel injection into the cylinders may be advanced proportionally with increasing rotational speed of the drive shaft.

A further object of the invention is to provide a fuel injection pump for a multicylinder internal combustion engine which is so constructed and assembled that the wear and tear upon the parts which transmit movements for varying the exact timing of fuel injection is reduced to a minimum.

An additional object of the invention is to provide a fuel injection pump of the type as outlined hereinabove in which the adjusting means for varying the exact timing of fuel injection in response to changes in output pressure of the fuel supply pump occupies little space, in which the adjusting means operates in a fully automatic way, and in which the adjusting means may be conveniently built into and/or attached to the housing of the fuel injection pump.

A still further object of the instant invention is to provide a fuel injection pump whose adjusting means for varying the exact time of actual fuel injection into the cylinders may be utilized regardless of the direction in which the drive shaft of the pump rotates.

A concomitant object of the invention is to provide an adjusting system for the fuel injection pumps of multicylinder internal combustion engines which is so constructed and asembled that the actual adjusting member is immediately responsive to very small changes in rotational speed of the drive shaft.

With the above objects in view, the invention resides essentially in the provision of a fuel injection pump whose drive shaft simultaneously operates a fuel supply pump and wherein the drive shaft rotates an injection piston which latter is axially shiftable by a multi-lobe crown cam. The cam effects axial shifting of the injection piston or distributor in a rhythm which depends upon the angular position of a normally stationary ring-like member comprising preferably roller-shaped elements which are in continuous rolling contact with the end surface of the rotating cam and, when engaging with the latter's lobes, axially shift the cam to effect corresponding axial movements of the piston. The adjusting means for the normally stationary ring and hence for the exact timing of fuel injection into the cylinders comprises a rotatable shaft member which is coupled with the aforementioned normally stationary ring in such manner that a certain angular adjustment of the ring corresponds to each angular movement of the shaft member. The latter is angularly adjustable by a reciprocable plunger which is constantly biased against the feed- or output pressure of a

fuel supply pump and is connected with the shaft member over a lever one end of which is articulately fixed to the adjusting plunger. Thus, whenever the feed pressure of the fuel supply pump and hence the angular speed of the drive shaft changes, the adjusting plunger angularly displaces the shaft member and the latter causes a corresponding angular movement of the ring so that the ring either advances or delays the time of fuel injection by the distributing piston.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following detailed description of a specific embodiment when read in connection with the accompanying drawings, in which:

FIG. 1 is partly elevational and partly sectional view of the improved fuel injection pump;

FIG. 2 is a section taken along the line II—II of FIG. 1, as seen in the direction of arrows; and

FIG. 3 is partly elevational view of the fuel injection pump as seen from the right-hand end of FIG. 1, and partial section taken along the line III—III of FIG. 1 as viewed in the direction of arrows.

Referring now in greater detail to the illustrated embodiment, and first to FIG. 1, there is shown a fuel injection pump P for a non-represented four-cylinder internal combustion engine which comprises a housing 1 rotatably mounting a drive shaft 2. The front end of the shaft 2 which is received in the housing 1 carries two diametrically opposed extensions or claws 3 constituting coupling means for drivingly connecting the shaft 2 with an axially shiftable follower disc 4. The follower 4 is provided with two diametrically opposed recesses or seats 4*a* for the extensions or claws 3 (see FIG. 3). The member 4 also comprises a second set of diametrically opposed recesses or seats 4*b* which receive the extensions or claws 5, the latter forming part of or connected with a discoid crown cam 6. The operative end surface of the cam 6 is formed with four lobes or projections 7 and the cam is constantly biased by one end of a resilient element, here shown as a helical spring 8, whose other end bears against the housing 1. The resilient means 8 urges the cam surface of member 6 against four rollers 9 which are rotatably mounted in a normally stationary ring 10, the latter being angularly adjustably inserted into the injection pump housing 1. The ring 10 and its rollers 9 constitute the normally stationary adjustable component of the cam drive for an injection piston 12. The ring 10 and the cam 6 is coaxial with the drive shaft 2.

The cam disc 6 constitutes the revolving or rotary component of the cam drive; its purpose is to operate the axially reciprocable injection pump piston 12 which also acts as a movable distributor element in a manner not further shown in the drawings. During each full revolution of the cam disc 6, four equal amounts of fuel are delivered in a given sequence through the distributor element 12 toward the four injection pump outlets 14.

The ring 10 rotatably supports a cylindrical articulation piece or joint 15 whose axis is parallel with the axis of the driving shaft 2. The joint 15 is slidably traversed by a cylindrical pin or stud 16 whose axis is perpendicular to the axis of the cylindrical member 15. The stud 16 is eccentrically anchored in and is parallel with a shaft member 17, i.e. this stud forms a crank pin on the latter. The shaft member 17 is tightly journaled in a casing 18. The casing 18 is fixed to the pump housing 1 and is formed with a cylindrical through bore 19 which slidably receives an adjusting plunger 20; the latter's axis is perpendicular to the axis of the shaft member 17.

The plunger 20 rotatably carries a cylindrical articula-

tion piece or joint 21 whose axis intersects at right angles the axis of the member 20, i.e. the axis of joint 21 is parallel with the axis of the shaft member 17 (see FIG. 2). The joint 21 slidably receives one end of a cylindrical pin or stud 22 whose other end is received in the shaft member 17. The axis of pin 22 is perpendicular to the axes of members 17, 21.

As is best shown in FIG. 2, one (the lower) end face of the plunger 20 is in contact with one terminal of a helical expansion or restoring spring 23 whose other terminal bears against the end wall of closure means for one open end of the bore 19 here shown as a sealing nipple 24. This closure means or nipple is removably threaded into the casing 18 and seals the lower end of the cylindrical bore 19 so that a cylindrical space or pressure chamber 25 is formed between its end wall and the adjacent end of the adjusting plunger 20. The other open end of the bore 19 is sealed by second closure means in the form of a plug 26 which is releasably threaded into the casing 18 and whose end wall forms with the adjacent end face of plunger 20 a second cylindrical space or chamber 27.

The pressures prevailing in the chamber 27 correspond to the feed pressure of a fuel supply pump whose rotary member 28 is fixed to and is rotatable with the drive shaft 2. The communication between the pressure side of the fuel supply pump and the pressure chamber 27 is established through ducts or channels 29, 30 (see FIG. 2). The suction side of the fuel supply pump represented by the rotary member 28 is in communication with the chamber 25 through a pair of ducts or channels 31, 32. A non-represented bypass or overflow throttle valve is provided in a non-illustrated conduit or channel which connects the suction side of the fuel supply pump with the latter's pressure side. The overflow valve brings about changes in the feed pressure of the fuel supply pump at a rate proportional with the variations in rotational speed of the drive shaft 2.

When the rotational speed of drive shaft 2 increases, the correspondingly increased feed- or output pressure of the fuel supply pump, which pressure also prevails in the chamber 27, causes the adjusting plunger 20 to slide in its bore 19 against the bias of restoring spring 23. Plunger 20 pivots the pin 22 by means of the joint 21 so that the pin 22 acts as a lever and causes a corresponding angular movement of the shaft member 17 (see FIG. 2). The eccentric crank pin 16 of shaft member 17 then angularly displaces the ring 10 by means of the joint 15, which results in an equal angular displacement of the rollers 9. Thus, any increase in the rotational speed of drive shaft 2, and hence in the feed pressure at the pressure side of the fuel supply pump, will advance the delivery of fuel by the injection pump P, i.e. the time of actual injection by the piston 12 is advanced as soon as the rotational speed of the drive shaft 2 increases. In other words, any changes in the timing of axial movements performed by the rotary component 6, 7 of the cam drive and hence by the injection piston 12 depend upon the angular displacement of the adjusting cam drive component 9, 10. The latter's angular adjustments are controlled by the constantly acting resilient restoring means 23 on the one hand, and by the output pressure of the fuel supply pump on the other hand. As stated hereinabove, the output pressure of the fuel supply pump depends upon the rotational speed of drive shaft 2.

Since the chamber 25 is connected with the suction side of the fuel supply pump, the opposing end faces of the adjusting plunger 20 are subjected to maximum pressure difference. The chamber 25 is fully sealed from the interior of the pump housing 1 and, consequently, the pressures prevailing therein correspond exactly to the pressures prevailing at the suction side of the fuel supply pump.

If it is desired to change the direction in which the drive shaft 2 rotates, and also to change the direction in which the ring 10 is to be turned in response to increasing angular speeds of the shaft 2, the mounting of members 24, 26 is reversed together with the plunger 20 and restoring spring 23. In other words, the suction side of the fuel supply pump then becomes the pressure side, and the pressures prevailing in the chamber 25 will then correspond to the feed pressure of the fuel supply pump.

It will be noted that the parts which transmit movements of the plunger 20 to the adjusting cam drive component 9, 10 are in contact with large surfaces so that the wear and tear upon these parts is reduced to a minimum.

It will be noted that the stroke of adjusting plunger 20 is comparatively large when compared with the corresponding maximum angular displacement of the ring 10. The diameter of the member 20 is comparatively small which, combined with the long stroke of said member, insures great capacity of the adjusting mechanism while its dimensions remain small so that the adjusting mechanism may be readily connected to and at least partially assembled directly in the housing of the fuel injection pump P.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can, by applying current knowledge, readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic and specific aspects of this invention and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed as new and desired to be secured by Letters Patent is:

1. In a fuel injecting arrangement for multicylinder internal combustion engines of the type comprising fuel supply pump means having an output side, rotary drive shaft means for operating said pump means in such a way that the pressure at said output side increases in response to increasing rotary speed of said shaft means, piston means for injecting measured quantities of fuel into the cylinders of the engine, and a cam drive for said piston means including a component angularly adjustable about a fixed axis for thereby regulating the timing of injection strokes performed by said piston means, the improvement which consists in the provision of means for angularly adjusting said component in response to variations in the rotary speed of said shaft means, said adjusting means comprising, in combination, a rotary shaft member coupled with said component for angularly displacing the same; cylinder means connected with the output side of said pump means; plunger means received in said cylinder means for movement in a first direction in response to increasing pressure at said output side; resilient means for permanently biasing said plunger means in a second direction counter to said first direction; and means for articulately connecting said plunger means with said shaft member so that the shaft member is rotated in response to movements of said plunger means in either of said directions.

2. In a fuel injecting arrangement for multicylinder internal combustion engines of the type comprising fuel supply pump means having an output side, rotary drive shaft means for operating said pump means in such a way that the pressure at said output side increases in response to increasing rotary speed of said shaft means, piston means for injecting measured quantities of fuel into the cylinders of the engine, and a cam drive for said piston means including a component angularly adjustable about a fixed axis for thereby regulating the timing of injection strokes performed by said piston means, the improvement which consists in the provision of means for angularly adjusting said component in response to variations in the rotary speed of said shaft means, said adjusting means comprising, in combination, a casing including cylinder means connected to the output side

of said pump means; a shaft member rotatably mounted in said casing and having an axis perpendicular to said fixed axis; means articulately connected with said shaft member and with said component for transforming rotary movements of said shaft member into angular displacements of said component; a plunger having an axis perpendicular to the axis of said shaft member and mounted in said cylinder means for movement in a first direction in response to increasing pressure at said output side; resilient means provided in said casing for permanently biasing said plunger in a second direction counter to said first direction; and an articulate connection between said plunger and said shaft member for transforming the movements of said plunger into rotary movements of said shaft member.

3. In a fuel injecting arrangement for multicylinder internal combustion engines of the type comprising fuel supply pump means having an output side, rotary drive shaft means for operating said pump means in such a way that the pressure at said output side increases in response to increasing rotary speed of said shaft means, piston means for injecting measured quantities of fuel into the cylinders of the engine, and a cam drive for said piston means including a component angularly adjustable about a fixed axis for thereby regulating the timing of injection strokes performed by said piston means, the improvement which consists in the provision of means for angularly adjusting said component in response to variations in the rotary speed of said shaft means, said adjusting means comprising, in combination, cylinder means connected to the output side of said pump means; a rotary shaft member having an axis perpendicular to said fixed axis; means articulately connected with said shaft member and with said component for transforming rotary movements of said shaft member into angular displacements of said component, said last mentioned means comprising a rotary cylindrical member eccentrically mounted in said component and a pin eccentrically received in said shaft member and slidably traversing said cylindrical member; a plunger having an axis perpendicular to the axis of said shaft member and mounted in said cylinder means for movement in a first direction in response to increasing pressure at said output side; resilient means provided in said casing for permanently biasing said plunger in a second direction counter to said first direction; and an articulate connection between said plunger and said shaft member for transforming the movements of said plunger into rotary movements of said shaft member.

4. In a fuel injecting arrangement for multicylinder internal combustion engines of the type comprising fuel supply pump means having an output side, rotary drive shaft means for operating said pump means in such a way that the pressure at said output side increases in response to increasing rotary speed of said shaft means, piston means for injecting measured quantities of fuel into the cylinders of the engine, and a cam drive for said piston means including a component angularly adjustable about a fixed axis for thereby regulating the timing of injection strokes performed by said piston means, the improvement which consists in the provision of means for angularly adjusting said component in response to variations in the rotary speed of said shaft means, said adjusting means comprising, in combination, cylinder means connected to the output side of said pump means; a rotary shaft member having an axis perpendicular to said fixed axis; means articulately connected with said shaft member and with said component for transforming rotary movements of said shaft member into angular displacements of said component; a plunger having an axis perpendicular to the axis of said shaft member and mounted in said cylinder means for movement in a first direction in response to increasing pressure at said output side; resilient means provided in said casing for permanently biasing said plunger in a second direction counter to said first direction; and an articulate connection between said plunger and said shaft member for transforming the movements of said plunger into rotary movements of said shaft member, said articulate connection comprising a cylindrical member mounted in and rotatable about an axis perpendicular to the axis of said plunger, and a stud extending radially from said shaft member and slidably received in said cylindrical member so that the shaft member is rotated when said plunger is moved in either of said directions.

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