

March 22, 1949.

T. K. VAN-TUYL
FUEL INJECTION PUMP

2,465,138

Filed Aug. 18, 1945

2 Sheets-Sheet 1

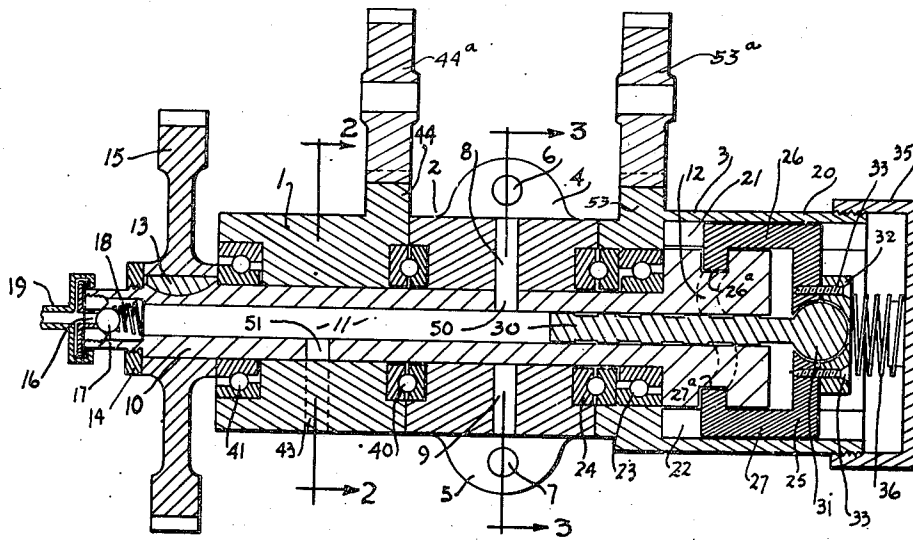


FIG 1

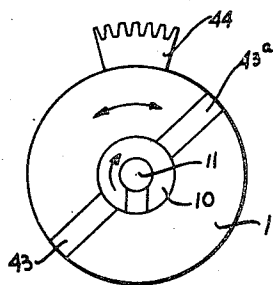


FIG 2

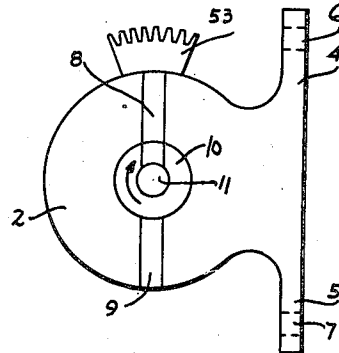


FIG 3



FIG 4

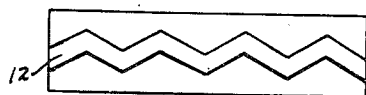


FIG 5

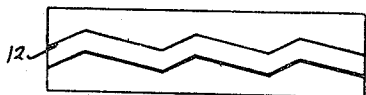


FIG 6

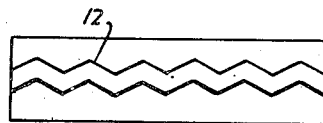


FIG 7

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2 Sheets-Sheet 2

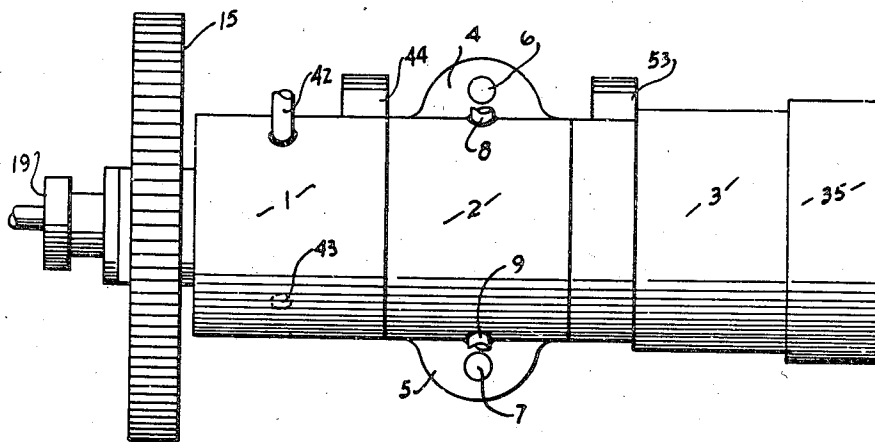


FIG 8

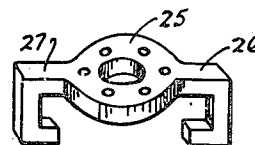


FIG 11

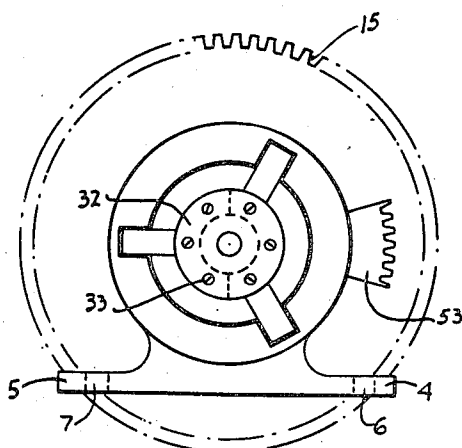


FIG 9

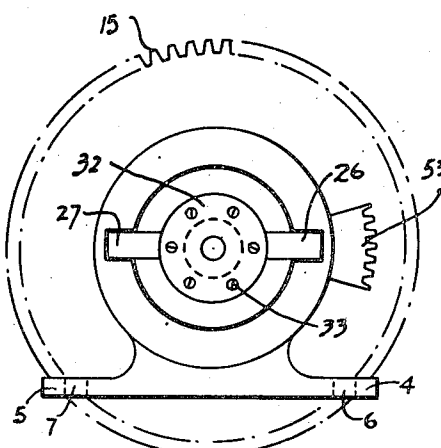


FIG 10

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2,465,138

FUEL INJECTION PUMP

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Application August 18, 1945, Serial No. 611,355

8 Claims. (Cl. 103—37)

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This invention relates to an improved fuel injection pump for internal combustion engines of the compression ignition type commonly known as Diesel engines.

The object of the invention is to devise a fuel injection pump that has a simple, compact, and efficient structure and arrangement of operating parts, including means for varying the quantity of fuel injected and for adjusting the timing in conjunction therewith. Another object is to provide a fuel injection pump which can be readily assembled, and is assembled as a unit with respect to the engine. A further object is to provide a pump plunger which is easily constructed and not subject to deflection due to high pressure encountered in fuel pumps.

Other objects and advantages will be more particularly seen hereinafter and will become apparent as the description proceeds.

In the accompanying drawings in which like reference numerals are used to designate similar parts throughout there is illustrated by way of example, a suitable mechanical embodiment for the purpose of disclosing the invention. The drawings, however, are for the purpose of illustration only and are not to be taken as limiting the invention, as it will be apparent to those skilled in the art that various changes in the illustrated construction may be resorted to without in any way exceeding the scope of the invention.

In the drawings:

Figure 1 is a longitudinal cross-section of the preferred form of my invention;

Figure 2 is a transverse cross-section taken through the line 2—2 of Figure 1;

Figure 3 is a transverse cross-section taken through the line 3—3 of Figure 1;

Figure 4 is a developed view of the annular cam for a two-cylinder engine;

Figure 5 is a developed view of the annular cam for a four-cylinder engine;

Figure 6 is a developed view of the annular cam for a three-cylinder engine;

Figure 7 is a developed view of the annular cam for a six-cylinder engine;

Figure 8 is a front elevation of my invention as it appears fully assembled;

Figure 9 is an end elevation of my invention with the cover removed, constructed for use with an engine having an even number of cylinders;

Figure 10 is an end elevation of my invention with the cover removed, constructed for use with a three-cylinder engine; and

Figure 11 is a perspective view of a cam fol-

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lower for use with an engine having an even number of cylinders.

Referring now more particularly to Figure 1 the device embodying my present invention consists of a body member having three main portions which I call the pressure reducing portion 1, the fuel distributor portion 2, and the piston actuating portion 3.

The fuel distributor portion 2 is a steel block of substantially circular shape with flanges 4 and 5 extending from one side thereof. These flanges are provided with holes 6 and 7 through which bolts may be inserted to attach the pump to the engine. Transversely piercing the fuel distributor portion are two fuel outlet passageways 8 and 9 which connect to the engine cylinders by means of suitable tubing.

Extending through the center of the fuel distributor portion 2 is a cylinder 10 rotatably mounted therein. The cylinder 10 has at the center thereof a compression chamber 11. The diameter of one end of said cylinder is considerably enlarged and an annular cam-shaped groove 12 is recessed in said enlarged portion. This groove preferably has the shapes shown in Figures 4, 5, 6 and 7, depending on the number of cylinders in the engine. At the other extremity of the cylinder is fixably mounted a gear 15 by means of a key 13 and a nut 14. At this end of the cylinder is also the fuel inlet port 16 and the fuel check valve which comprises ball 17 retained against its seat by compression spring 18. Outlet port 50 and pressure reducing port 51 transversely pierce the wall of cylinder 10 respectively opposite the distributor portion 2 and the pressure reducing portion 1 of the body member.

Since the cylinder rotates whereas of course the fuel inlet lines do not rotate, a rotary connector 19 which may be of any well known construction must be provided between the cylinder and the fuel lines.

The piston actuating portion 3 of the body member comprises a hollow cylindrical housing 20 having therein longitudinal grooves 21 and 22. This housing 20 is mounted around the enlarged end of the cylinder 10 and suitable radial and thrust bearings 23 and 24 are provided to permit rotation of the cylinder 10 with respect to the housing 20, and also to permit rotation of the housing 20 with respect to the fuel distributor portion 2.

Travelling in reciprocating fashion in the grooves 21 and 22 of the housing 20 is a cam follower 25 which in my preferred construction is a

C-shaped metal bar having legs 26 and 27 and upstanding lugs 26a and 27a at the ends thereof; the legs 26 and 27 of the C-shaped bar are the portions which travel in and are guided by the grooves 21 and 22. The lugs 26a and 27a fit in the annular cam-shaped recess 12 of cylinder 10. Reciprocating in the compression chamber 11 of cylinder 10 is a piston 30 one end of which projects beyond the compression chamber and is shaped in the form of a ball 31. The ball 31 fits in a hole at the center of the cam follower member 25, and a retainer 32 also having a hole therein is tightly held by bolts 33 to the cam follower 25. The holes in the cam follower 20 and in the retainer 32 are so machined that when taken together they form a socket for the ball 31 of the piston 30.

At the end of the housing 20 is screwed a cover 35, and between the cover 35 and the retainer 32 is placed a helical compression spring 36. Extending from the housing 20 is a gear segment 53 which engages with a suitable gear 53a and adjustment by this gear thereby controls the radial position of the piston actuating portion 3 of the body member with respect to the distributor portion 2 of the body member.

The pressure reducing portion 1 of the body member is a cylindrical block having a hole at its center in which rotates the cylinder 10. Thrust bearing 40 and radial bearing 41 are provided to mount the cylinder 10 in the pressure reducing portion 1 of the body member and allow the rotation of one with respect to the other. Transversely piercing the pressure reducing portion 1 of the body member are outlet passageways 43 and 43a which engage with the pressure reducing port 51 in the cylinder as the cylinder rotates.

Extending from the pressure reducing portion 1 of the body member is a gear segment 44 which engages with a suitable gear 44a and adjustment by this gear thereby controls the radial position of the pressure reducing portion 1 of the body member with respect to the distributor portion 2 of the body member.

In operation the gear 15 engages with a train of gears connecting to the main crank shaft of the engine and the cylinder 10 thereby rotates synchronously with the engine. As the cylinder 10 rotates the lugs 26a and 27a of the cam follower 25 must naturally travel in the annular cam recess 12 of the cylinder, and since the grooves 21 and 22 of the housing prevent rotation of the cam follower 25 said cam follower is forced to reciprocate in the housing. The piston 30 which is attached to the cam follower 25 by means of the ball and socket joint travels with said cam follower and therefore reciprocates in the compression chamber. The ball and socket joint between the piston and the cam follower allows some flexibility between the piston and the cam follower and thereby reduces the bending stresses in these parts.

The fuel enters the compression chamber through the inlet port 16 on the suction stroke of the piston; and on the compression stroke the check valve closes and the fuel is compressed in the compression chamber; when the outlet port 50 of the cylinder arrives opposite the outlet passageways 8 or 9 of the distributor portion 2 of the body member the fuel is injected under pressure through said passageways into the engine.

It will be noted from a comparison of Figures 2 and 3 that the pressure reducing passageways 43 and 43a are radially spaced apart from the outlet passageways 8 and 9 by about 30° whereas

the pressure reducing port 50 is radially spaced apart from the outlet port 51 by 180° and therefore the outlet port 50 engages with an outlet passageway 8 or 9 at an earlier time than the pressure reducing port 51 engages with a pressure reducing passageway 43 or 43a. As soon as the pressure reducing port 51 engages with a pressure reducing passageway 43 or 43a there is a sudden drop in pressure and whatever fuel may remain in the compression chamber takes the line of least resistance through a pressure reducing passageway and returns to the fuel tank. By providing the pressure reducing port and passageways, the pressure of the injected fuel drops suddenly and dribbling of the injected fuel is thereby eliminated. If the pressure reducing portion 1 of the body member is rotated, say counter-clockwise as viewed in Figure 2, it is obvious that the pressure reducing port 51 of the cylinder will engage with the pressure reducing passageways at an earlier time. This means that the pressure of the injected fuel will drop sooner and also that the quantity of fuel injected will be less. Therefore by these means the quantity of injected fuel can be accurately controlled and metered.

Since the radial position of the piston actuating portion 3 of the body member with respect to the distributor portion 2 of the body member can be varied by rotation of the gear 53a engaging with the gear segment 53, the time instant when the pressure stroke commences can be advanced. Concurrently, the outlet port 50 in the cylinder 10 will register with an outlet passageway 43 or 43a in the distributor portion 2 of the body member several degrees earlier thus making possible the aforementioned variation in the time of commencement of the pressure stroke. Thus ignition advance can be effected; obviously, a converse operation will produce ignition retardation.

It is obvious that the compression stroke demands a much greater amount of power than the suction stroke and therefore in order to balance these two strokes the compression spring 36 is provided. This spring 36 stores up energy during the suction stroke which is expended during the compression stroke; it therefore balances the power used during both strokes.

Figures 4, 5, 6 and 7 which show developed views of various types of annular cam recesses 12 in the enlarged part of cylinder 10 are illustrative only, and it is quite possible that some modification in their shape would be desirable; for example the corners might be rounded out in order to give smoother accelerations of the piston. It should be noted that the compression stroke is rapid in all cases whereas the time for the suction stroke varies with the number of cylinders in the engine; for example in a two-cylinder engine the suction stroke is slow, whereas for the six-cylinder engine the suction stroke is much more sudden.

Figure 10 which is an end view of the preferred form of my device shows the cam follower to have two legs 26 and 27 only. This type of cam follower can be used with any engine having an even number of cylinders. With other engines, for example a three-cylinder engine, the design of the cam follower has to be changed, otherwise the stresses in the cam follower would destroy it. In Figure 9 is shown a three-legged cam follower for use with a three-cylinder engine. It should be noted here that in order to enable the lugs of the cam follower to be inserted in the

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annular cam recesses, it is necessary to split the cam follower in two parts at its center. After the cam follower is assembled and its lugs are fitted in the annular cam recess, the retainer 32 holds the whole assembly together securely.

Having thus described my invention it is thought that the construction and use of the invention will be apparent from the above description of the various parts and their purpose. It is to be understood that the form of my invention herewith shown and described, is to be taken as a preferred example of the same, and that various changes in the shape, size and arrangement of parts may be resorted to, without departing from the spirit of my invention, or the scope of the claims.

I claim:

1. A fuel injection pump for an engine comprising a rotatable cylinder; means adapted to engage with an engine for rotating the cylinder in synchronism therewith; fuel outlet and pressure releasing ports in said cylinder; a fuel inlet port at one end of the said cylinder; a body member in which said cylinder rotates, said body member having a plunger actuating portion, a distributor portion, and a pressure releasing portion, one of said portions being adapted to be fixedly mounted to an engine, the other two portions being radially adjustable about the cylinder; means to rotate said other two portions relative to the fixed portion; a passageway in the distributor portion of the body member adapted to register with the fuel outlet port as the cylinder rotates; valve means for obtaining unidirectional flow through the inlet port; a passageway in the pressure releasing portion of the body member adapted to register with the pressure releasing port as the cylinder rotates; a plunger reciprocable in the cylinder to provide an induction stroke and a compression stroke; means in the plunger actuating portion to reciprocate the plunger; the radial position of one of the radially adjustable portions with respect to the fixed portion determining the timing of the plunger strokes, and the radial position of the other radially adjustable portion determining the time when the pressure releasing port registers with the pressure releasing passageway thereby relieving the pressure in the pump and limiting the quantity of fuel injected through the outlet port and passageway.

2. A fuel injection pump for an engine comprising a rotatable cylinder; means adapted to engage with an engine for rotating the cylinder in synchronism therewith; fuel outlet and pressure releasing ports in said cylinder; a fuel inlet port at one end of the said cylinder; a body member in which said cylinder rotates, said body member having a plunger actuating portion, a distributor portion, and a pressure releasing portion, one of said portions being adapted to be fixedly mounted to an engine, the other two portions being radially adjustable about the cylinder; gear sectors respectively secured to the said radially adjustable portions and adapted to rotate the said radially adjustable portions with respect to the fixed portion; means to rotate the said gear sectors; a passageway in the distributor portion of the body member adapted to register with the fuel outlet port as the cylinder rotates; valve means for obtaining unidirectional flow through the inlet port; a passageway in the pressure releasing portion of the body member adapted to register with the pressure releasing port as the cylinder rotates; a plunger reciprocable in the

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cylinder to provide an induction stroke and a compression stroke; means in the plunger actuating portion to reciprocate the plunger; the radial position of one of the radially adjustable portions with respect to the fixed portion determining the timing of the plunger strokes, and the radial position of the other radially adjustable portion determining the time when the pressure releasing port registers with the pressure releasing passageway thereby relieving the pressure in the pump and limiting the quantity of fuel injected through the outlet port and passageway.

3. A fuel injection pump comprising a rotatable cylinder; means for rotating the cylinder; an annular cam-shaped recess at one end of the cylinder; fuel outlet and pressure releasing ports in said cylinder; a fuel inlet port at one end of the said cylinder; a body member in which said cylinder rotates, said body member having a plunger actuating portion, a distributor portion, and a pressure releasing portion; a passageway in the distributor portion of the body member adapted to register with the fuel outlet port as the cylinder rotates; valve means for obtaining unidirectional flow through the inlet port; a passageway in the pressure releasing portion of the body member adapted to register with the pressure releasing port as the cylinder rotates; a plunger reciprocable in the cylinder; a cam follower connected to the plunger and engaging with the cam-shaped recess in the cylinder whereby rotation of the cylinder imparts reciprocation to the plunger.

4. A fuel injection pump comprising a rotatable cylinder; means for rotating the cylinder; an annular cam-shaped recess at one end of the cylinder; fuel outlet and pressure releasing ports in said cylinder; a fuel inlet port at one end of the said cylinder; a body member in which said cylinder rotates, said body member having a plunger actuating portion, a distributor portion, and a pressure releasing portion; a passageway in the distributor portion of the body member adapted to register with the fuel outlet port as the cylinder rotates; valve means for obtaining unidirectional flow through the inlet port; a passageway in the pressure releasing portion of the body member adapted to register with the pressure releasing port as the cylinder rotates; a plunger reciprocable in the cylinder; a cam follower connected to the plunger; said cam follower engaging with the cam-shaped recess in the cylinder whereby rotation of the cylinder imparts reciprocation to the plunger; and means to prevent rotation of the cam follower relative to the body member, said means including longitudinal grooves in the plunger actuating portion of the body member in which the cam follower reciprocates.

5. A fuel injection pump comprising a rotatable cylinder; means for rotating the cylinder; an annular cam-shaped recess at one end of the cylinder; fuel outlet and pressure releasing ports in said cylinder; a fuel inlet port at one end of the said cylinder; a body member in which said cylinder rotates, said body member having a plunger actuating portion, a distributor portion, and a pressure releasing portion; a passageway in the distributor portion of the body member adapted to register with the fuel outlet port as the cylinder rotates; valve means for obtaining unidirectional flow through the inlet port; a passageway in the pressure releasing portion of the body member adapted to register with the

pressure releasing port as the cylinder rotates; a plunger reciprocable in the cylinder to provide an induction stroke and a compression stroke; a cam follower connected to the plunger and engaging with the cam-shaped recess in the cylinder whereby rotation of the cylinder imparts reciprocation to the plunger; a cover on the end of the piston actuating portion; and compression spring means between said cover and the piston to boost the piston on its compression stroke.

6. A fuel injection pump for an engine, comprising a rotatable cylinder; means adapted to engage with an engine for rotating the cylinder in synchronism therewith; an annular cam-shaped recess at one end of the cylinder; fuel outlet and pressure releasing ports in said cylinder; a fuel inlet port at one end of the said cylinder; a body member in which said cylinder rotates, said body member comprising a plunger actuating portion, a distributor portion, and a pressure releasing portion, the distributor portion being adapted to be fixed to an engine and the other two portions being rotatable about the cylinder; means to individually vary the radial position of the said other two portions with respect to each other and to the distributor portion, said means including gear sectors fixed to said portions; a passageway in the distributor portion of the body member adapted to register with the fuel outlet port as the cylinder rotates; valve means for obtaining unidirectional flow through the inlet port; a passageway in the pressure releasing portion of the body member adapted to register with the pressure releasing port as the cylinder rotates; a plunger reciprocable in the cylinder to provide an induction stroke and a compression stroke; a cam follower connected to the plunger and engaging with the cam-shaped recess in the cylinder whereby rotation of the cylinder imparts reciprocation to the plunger; the radial position of the plunger actuating portion of the body member with respect to the distributor portion of the body member determining the timing of the plunger strokes, and the radial position of the pressure releasing portion of the body member with respect to the distributor portion of the body member determining the time when the pressure releasing port registers with the pressure releasing passageway thereby relieving the pressure in the pump and limiting the quantity of fuel injected through the outlet port and passageway.

7. A fuel injection pump for an engine, comprising a rotatable cylinder; means adapted to engage with an engine for rotating the cylinder in synchronism therewith; an annular cam-shaped recess at one end of the cylinder; fuel outlet and pressure releasing ports in said cylinder; a fuel inlet port at one end of the said cylinder; valve means for obtaining unidirectional flow through the inlet port; a body member in which said cylinder rotates, said body member comprising a plunger actuating portion, a distributor portion, and a pressure releasing portion, one of the said portions being fixedly mounted to an engine, the other two portions being radially adjustable about the cylinder; means to individually vary the radial position of the said other two portions with respect to each other and with respect to the fixed portion; a passageway in a distributor portion of the body member adapted to register with the fuel outlet port as the cylinder rotates; a passageway in the pressure releasing portion of the body member adapted to register with the pressure re-

leasing port as the cylinder rotates; a plunger reciprocable in the cylinder to provide an induction stroke and a compression stroke; a cam follower connected to the plunger and engaging with the cam shaped recess in the cylinder whereby rotation of the cylinder imparts reciprocation to the plunger; the radial position of one of the radially adjustable portions with respect to the fixed portion determining the timing of the plunger strokes, and the radial position of the other radially adjustable portion determining the time when the pressure releasing port registers with the pressure releasing passageway thereby relieving the pressure in the pump and limiting the quantity of fuel injected through the outlet port and passageway.

8. A fuel injection pump for an engine, comprising a rotatable cylinder; means adapted to engage with an engine for rotating the cylinder in synchronism therewith; an annular cam shaped recess at one end of the cylinder; fuel outlet and pressure releasing ports in said cylinder; a fuel inlet port at one end of the said cylinder; valve means for obtaining unidirectional flow through the inlet port; a body member in which said cylinder rotates, said body member comprising a plunger actuating portion, a distributor portion, and a pressure releasing portion, the distributor portion being adapted to be fixed to an engine and the other two portions being rotatable about the cylinder; means to individually vary the radial position of the said other two portions with respect to each other and to the distributor portion; a passageway in the distributor portion of the body member adapted to register with the fuel outlet port as the cylinder rotates; a passageway in the pressure releasing portion of the body member adapted to register with the pressure releasing ports as the cylinder rotates; longitudinal grooves in the plunger actuating portion of the body member; a plunger reciprocable in the cylinder to provide an induction stroke and a compression stroke; means in the plunger actuating portion of the body member to reciprocate the plunger, the said means comprising a cam follower connected to the plunger and having longitudinally extending legs provided with lugs at their extremity; the legs engaging with the longitudinal grooves in the plunger actuating portion of the body member and the lugs engaging with the cam shaped recess in the cylinder whereby rotation of the cylinder imparts reciprocation to the plunger; the radial position of one of the radially adjustable portions with respect to the fixed portion determining the timing of the plunger strokes, and the radial position of the other radially adjustable portion determining the time when the pressure releasing port registers with the pressure releasing passageway thereby relieving the pressure in the pump and limiting the quantity of fuel injected through the outlet port and passageway.

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