March 20, 1934. H. A. BOHUSLAV 1,951,340

FUEL PUMP FOR INTERNAL COMBUSTION ENGINES

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FIG. 1.

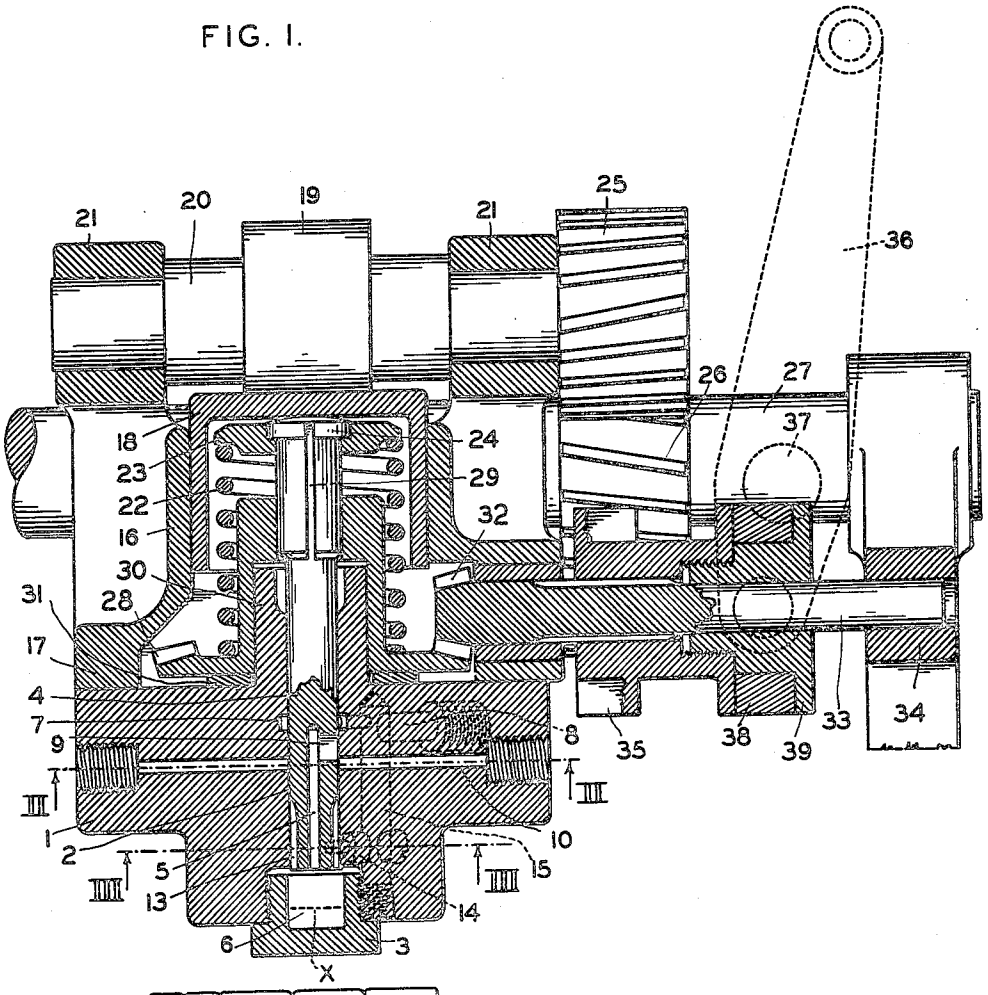
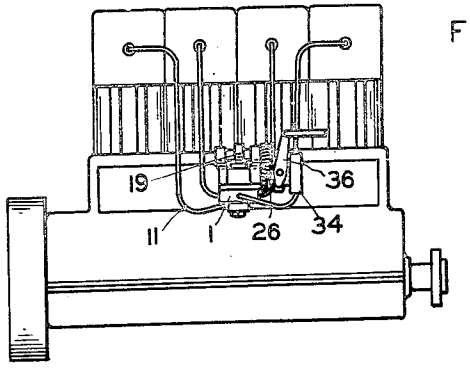



FIG. 6.




INVENTOR.
HANS A. BOHUSLAV
BY Baldwin & Wile
ATTORNEY.

March 20, 1934. H. A. BOHUSLAV 1,951,340

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FIG. 5.

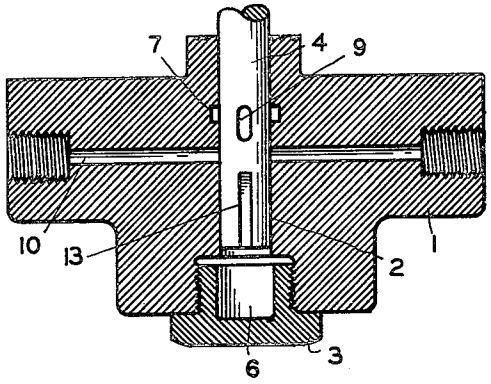



FIG. 2.

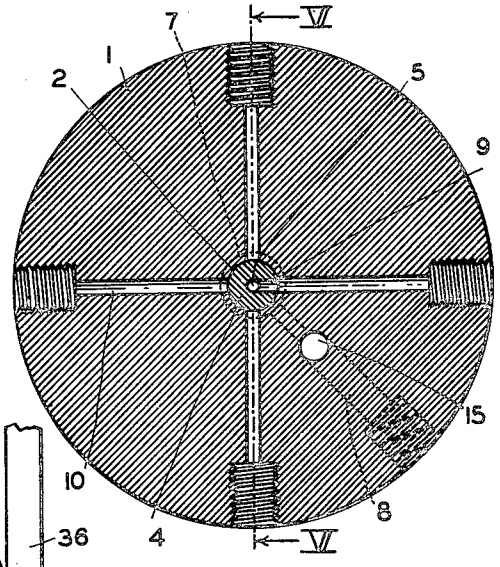



FIG. 4.

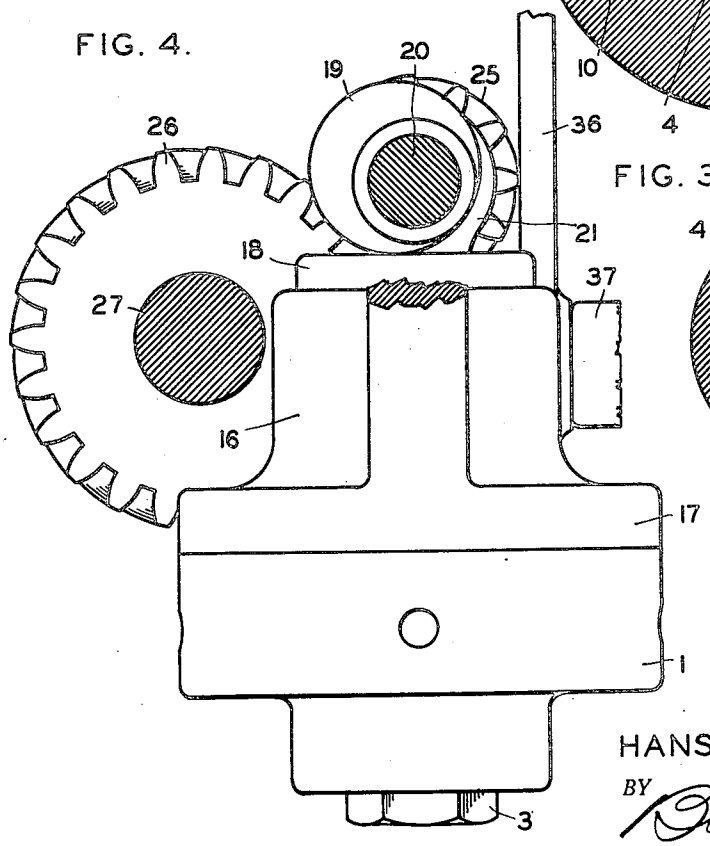
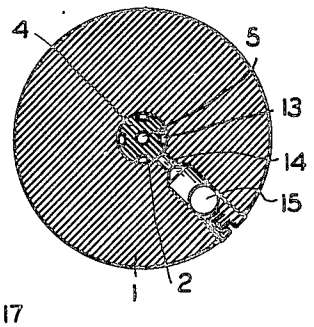



FIG. 3.




*INVENTOR.*

HANS A. BOHUSLAV.

*BY* Baldwin & Vale

*ATTORNEY.*

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# UNITED STATES PATENT OFFICE

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## FUEL PUMP FOR INTERNAL COMBUSTION ENGINES

Hans A. Bohuslav, San Francisco, Calif.

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7 Claims. (Cl. 103—2)

This invention relates to improvements in fuel pumps for internal combustion engines.

Among the objects of the invention is to accomplish precision in the quantity, pressure, and timing of the fuel injection into the combustion chamber.

Another object is to provide a variable control in the timing of the injection cycle.

Another object is to eliminate the necessity for maintaining the fuel under prolonged high pressure.

Another object is to combine the fuel pump and fuel distributor, to establish precision in the coordination of these mechanisms.

A further object is to establish uniformity in the fuel supply to the several cylinders of a multicylinder engine.

Other objects and advantages will appear as the description progresses.

In this specification and the accompanying drawings the invention is disclosed in its preferred form. It is to be understood, however, that it is not limited to this form because it may be embodied in other forms within the spirit of the invention, as defined in the claims following the description.

In the accompanying two sheets of drawings:

Fig. 1 is a vertical section of a distributing fuel pump constructed in accordance with this invention.

Fig. 2 is a horizontal section of the same taken along the line II—II, Fig. 1, and viewed from beneath.

Fig. 3 is a similar view taken along the line III—III, Fig. 1.

Fig. 4 is an end elevation view of the pump, certain parts being broken away to disclose the underlying mechanism.

Fig. 5 is a fragmentary vertical section taken along the line V—V in Fig. 2 and showing the pump plunger in its initial position.

Fig. 6 is a diagrammatic side elevation of an internal combustion engine having the present fuel injection system installed therein.

In detail, the construction illustrated in the drawings, referring more particularly to Fig. 1, comprises the pump body 1 having the axial bore 2 therethrough closed at its lower end by the threaded plug 3. The plunger 4 is slidable within the bore 2 and has the central passage 5 drilled therein. The plug 3 has the pump chamber 6 cored therein to receive the end of the plunger during its working stroke.

The annular groove 7 intermediate the height of the bore 2 encircles the plunger 4 and has the fuel supply passage 8 leading thereto. A pipe (not shown) leading from a suitable source of fuel oil is screwed into the end of the supply passage 8. The port 9 is milled through the side of the plunger 4 and communicates with the central passage 5. When the plunger 4 is in the initial inoperative position shown in Fig. 5, the upper end of the port 9 registers with the supply groove 7 to feed fuel into the passage 5.

The discharge outlets 10 are drilled radially through the pump body (see also Fig. 2) and intersect the bore 2 at points equidistant from each other. The outlets 10 are so located that the port 9 will be brought into alignment therewith during the downward stroke of the plunger as illustrated in Fig. 1. The number of the outlets 10 corresponds with the number of cylinders of the engine to which the fuel injection system is applied. In the present instance, the system is installed in a Diesel engine having four cylinders. Feed lines such as 11 are screwed into the ends of each of the discharge outlets 10 and are connected to suitable injectors (not shown) for injecting the fuel oil into the combustion chambers of the engine.

The lower end of the plunger 4 has the interspaced external flutes 13 of a number to correspond with the outlets 10 and are adapted to be successively brought into registry with the relief port 14 which communicates with the fuel supply passage through the intermediate passage 15.

The tubular sleeve 16 has the flange 17 bolted to the top of the body 1 and guides the inverted cup 18 resting on the top of the plunger 4. The cam 19 impinges on the top of the cup 18 to drive the reciprocating plunger 4 and is fixed on the shaft 20 which is rotatably mounted in the bearings 21—21 integral with the sleeve 16. The spring 22 expands upwardly against the seat 23 swiveled on the plunger 4 beneath the flanged head 24. The spring thus maintains the plunger and the interposed cup 18 in operative engagement with the cam 19 and serves to restore the plunger to its initial position after being depressed by the cam.

The pinion 25 is mounted on the end of the camshaft 20 and is enmeshed with the helical gear 26 fixed on the driveshaft 27 to drive the cam 19. The shaft 27 may be any convenient shaft of the engine rotating at the same speed and in synchronism with the crankshaft (not shown). The pinion and gear 25, 26, establish a 2:1 ratio between their respective shafts to

drive the cam 19 at twice the speed of the crankshaft.

The plunger is continuously rotated to bring the port 9 successively into registry with each of the discharge outlets 10 by the bevel gear 28 engaging the splined portion 29 of the plunger. The bevel gear is rotatably mounted on the neck 30 extending upward from the body 1 and stepped into the gear. The washer 31 is interposed between the gear 28 and the top of the body 1 to minimize the friction therebetween. The bevel gear is driven by the bevel pinion 32 on the end of the shaft 33, which is rotatably mounted in the flange 16 and the out bearing 34. The shaft 33 is actuated by the helical pinion 35 splined thereon and enmeshed with the helical driving gear 26.

The pinion 35 may be moved laterally with respect to the gear 26 by the control lever 36 pivoted at 37 and operatively engaging the collar 38 swiveled in the block 39 which is threaded in the side of the pinion 35. Lateral movement of the collar 38 slides the pinion against the angularly disposed teeth of the helical gear 26, thus slightly rotating the shaft 33 in relation to the drive shaft 27. This advances or retards the timing of the rotation of the plunger 4 with respect to the timing of the engine for purposes to be later described.

The invention operates substantially as follows: When the plunger 4 is in its initial position as shown in Fig. 5, the port 9 registers with the supply groove 7 and permits the fuel oil therein to flow down the passage 5 to completely fill the pump chamber 6. The supply of fuel oil should be maintained under sufficient pressure to overcome its viscosity and insure its flow into the pump chamber.

The rotation of the cam 19 brings its raised portion into engagement with the cup 18 and depresses the plunger against the tension of the spring 22. The descent of the plunger lowers the port 9 into registry with one of the discharge outlets 10. The outlet selected depends upon the radial position of the plunger which is continuously rotated in synchronism with the engine cycles by the bevel gear 28. As the descent of the plunger progresses, the port 9 passes out of registry with the groove 7, cutting off the pump chamber 6 from the source of fuel supply. The exact point at which the port 9 passes from registry with the supply groove accurately predetermines the commencement of the injection cycle.

The descent of the plunger 4 displaces the fuel oil in the pump chamber 6 therebeneath and forces the fuel upward through the passage 5 and the selected outlet 10. The port 9 is sufficiently long to register with the outlet 10 throughout the operative stroke of the plunger 4. From the outlet 10, the fuel passes into a feed line 11 and is delivered to the proper fuel injector unit (not shown).

The form of fuel injector best adapted for use in conjunction with the present invention is the automatic pressure valve type. When the pressure of the fuel is raised to the proper point by the force of the pump plunger 4, the valve of the injector yields and admits the fuel into the combustion chamber of the engine in the usual manner. It will be obvious to those skilled in the art that other forms of injectors are adapted for use in combination with the present distributing pump.

The plunger 4 is continuously rotated at one-half crankshaft speed and in synchronism therewith by the gear drive 26, 35 and 32, 28. This rotation of the plunger brings one of the flutes 13 into alignment with the relief port 14 as the plunger descends to the desired point $x$ (see dotted lines, Fig. 1) in the latter portion of its stroke. This permits the oil in the pump chamber to flow through the relief port and the passage 15 back into the supply passage, thus immediately relieving the pressure of the pump and ceasing the flow of fuel to the injector.

The port 9 and the outlet 10 are required to be of sufficient width so that the incidental rotary movement of the plunger will not completely remove the port from alignment with the outlet until after the fuel delivery is completed.

The relative radial positions of the driveshaft 27 and the plunger 4 are varied by operating the control lever 36 to slide the helical gear 35 laterally, as before described. The radial position of the plunger may thus be advanced or retarded with respect to the means for reciprocating the plunger to bring the flutes 13 into alignment with the relief port at any desired point in the downward stroke of the plunger. The duration of the fuel feed may thus be easily controlled to lengthen or curtail the injection cycle and the quantity of fuel injected.

When the cam 19 completes its operative movement, the spring 22 restores the plunger to its initial position. The upward movement of the plunger draws fuel oil from the supply passage through the port 14 and the registering flute 13 into the pump chamber 6 to replace the fuel pumped therefrom.

When the plunger is fully restored to its initial position, the port 9 is again brought into registry with fuel supply groove 7. The flow of oil therefrom insures the complete filling of the pump chamber before a succeeding cycle of operation is initiated.

The rotation of the plunger 4 then moves the port 9 into alignment with the adjoining discharge outlet 10 in the pump body 1. The operation of the pump is then repeated to deliver the proper amount of fuel to the second cylinder of the engine. The remaining engine cylinders are similarly fed with fuel in the usual order by the succeeding operation cycles of the pump.

It is to be noted that the camshaft 20 of the present apparatus rotates at twice the speed of the engine crankshaft. In prior constructions wherein the injectors are individually cam operated, it is necessary to arrange the camshaft to rotate at one-half the crankshaft speed. The greater speed of the camshaft under the present invention permits the use of a cam having a relatively easy rise, thus overcoming one of the serious engineering difficulties of the existing Diesel engine.

Having thus described this invention, what is claimed and desired to be secured by Letters Patent is:

1. In an injection system for internal combustion engines, a distributing pump comprising a body having a chamber and a fuel supply groove therein, a plunger in said body slidable into said chamber and having a port in the side thereof communicating with said chamber and adapted to register with said groove when the plunger is in its initial position, means for reciprocating said plunger, a series of radially disposed outlets in said body arranged to register with said port during the working movement of the plunger, and means for rotating the plunger at prede-

termined speed with respect to said reciprocating means.

2. In an injection system for internal combustion engines, a distributing pump having a chamber and a series of interspaced outlets therein; means for introducing fuel into said chamber; a plunger slidable in said body, having a port therein communicating with said outlets, and adapted to displace the fuel in said chamber through said outlets; means for reciprocating said plunger; means for rotating said plunger; a shaft for driving both the means for reciprocating and rotating the plunger in unison; and means for varying the radial position of said plunger with respect to said shaft.

3. A fuel distributing pump for internal combustion engines comprising a body having a chamber, relief port, and a plurality of interspaced outlets therein; means for introducing fuel into said chamber, a plunger slidable in said body and having a port therein adapted to register with said outlets; means for reciprocating said plunger to displace the fuel in said chamber through said outlets; means for rotating said plunger in timed relation to said reciprocating means; flutes in said plunger communicating with said chamber and adapted to be brought successively into alignment with said relief port by the rotation of said plunger.

4. A fuel distributing pump for internal combustion engines comprising a body having a bore, a chamber and a series of radially disposed outlets therein; a plunger slidable in said bore and having a port therein communicating with said chamber and adapted to register with said outlets; a fuel inlet in said bore communicating with said chamber when said plunger is in its initial position; means for reciprocating said plunger to displace the fuel in said chamber through said outlets; and means for rotating said plunger at predetermined speed with respect to said reciprocating means.

5. A fuel distributing pump for internal combustion engines comprising a body having a bore, a chamber and a series of radially disposed outlets therein; a plunger slidable in said bore and having a port therein communicating with said chamber and adapted to register with said outlets; means for introducing fuel into said chamber; means for reciprocating said plunger to displace the fuel in said chamber through said outlets; means for rotating said plunger at predetermined speed with respect to said reciprocating means; a relief port in said bore adapted to be covered by said plunger; and means for uncovering said port after said plunger performs a predetermined portion of its operative movement.

6. A fuel distributing pump for internal combustion engines comprising a body having a bore and a chamber therein; a source of fuel supply; a groove and relief port in said bore each communicating with said source of fuel supply; a plunger slidable in said bore and having a port in the side thereof communicating with said chamber adapted to register with said groove when said plunger is in its initial position; means for reciprocating said plunger; means for rotating said plunger in timed relation to said reciprocating means; a series of interspaced outlets in said body adapted successively to register with said port during the working movement of said plunger; and flutes in said plunger communicating with said chamber and adapted to register with said relief port during the latter portion of the operative movement of the plunger and during its restoration movement.

7. A fuel distributing pump for internal combustion engines comprising a body having a chamber and a series of interspaced outlets therein; a plunger slidable in said body and having a port therein communicating with said chamber and adapted to register with said outlets; means for introducing fuel into said chamber; means for reciprocating said plunger to displace the fuel in said chamber through said outlets; a neck extending from said body; a gear rotatably mounted on said neck and axially splined to said plunger; and means for driving said gear in timed relation to said reciprocating means.

HANS A. BOHUSLAV.