

Feb. 21, 1961

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2,972,307

MULTI-PLUNGER INJECTION PUMP

Filed March 25, 1957

2 Sheets-Sheet 1

FIG. 1.

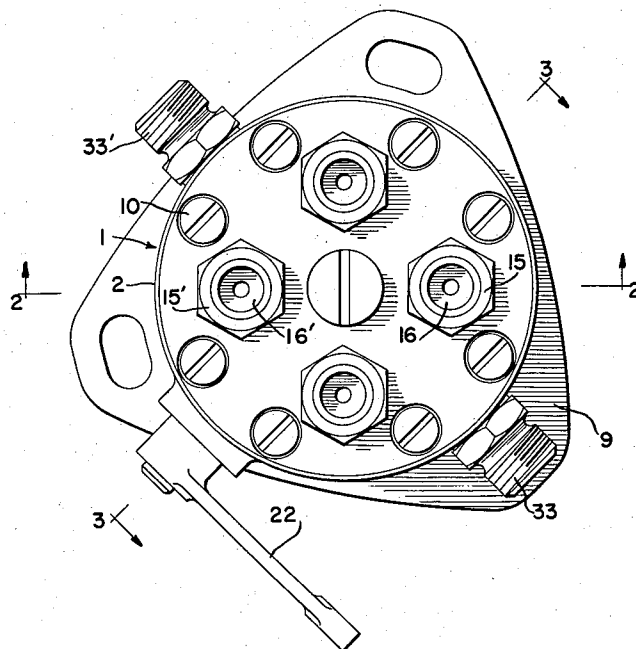
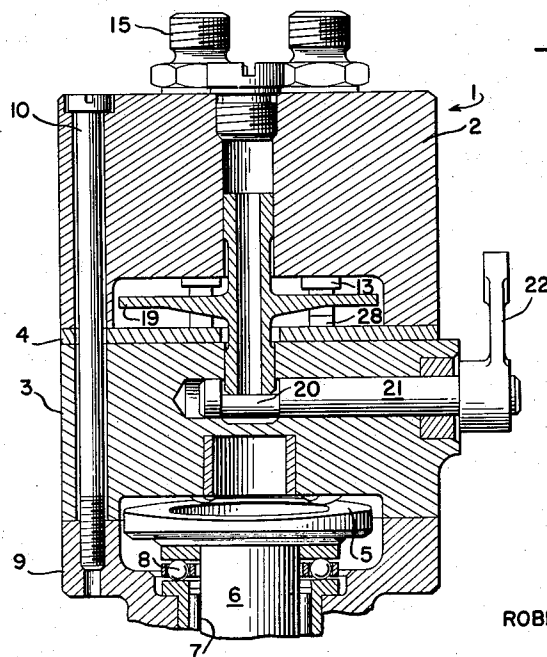


FIG. 3.



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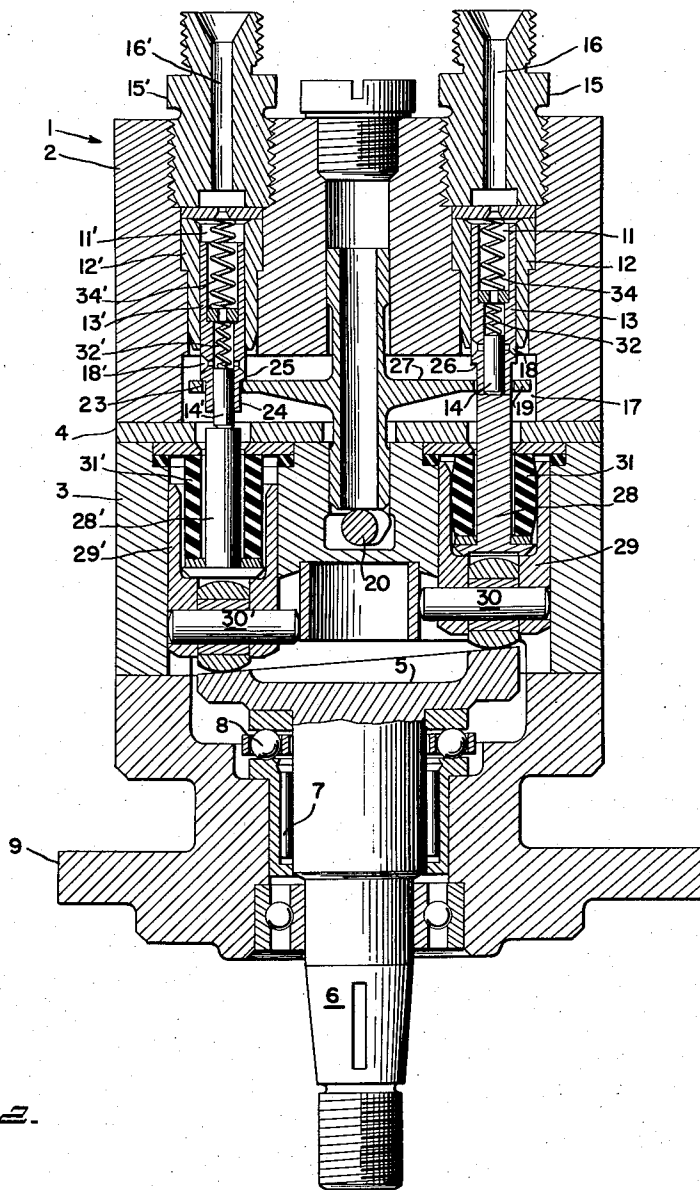


FIG. 2.

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MULTI-PLUNGER INJECTION PUMP

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Filed Mar. 25, 1957, Ser. No. 648,058

Claims priority, application Germany Apr. 20, 1956

12 Claims. (Cl. 103—38)

The present invention relates to a multi-plunger injection pump for internal combustion engines, and more particularly to a drum-type injection pump including a pump housing and a control housing arranged one above the other with a seal therebetween.

In the injection pump according to the present invention a plurality of pumping units may be arranged symmetrically with respect to the center axis of the pump unit and with the axes of the individual pumping units or cylinders disposed in parallel.

The present invention resides in that the pump piston of the drum-type injection pump consists of a plurality of piston parts or plunger elements, preferably of two such piston parts, arranged concentrically with respect to each other, and in that one of the two piston parts serves as the means for metering the quantity of fuel supplied to the pumping unit.

Moreover, in accordance with a further development of the present invention, commencement of the actuation of the two piston parts or plunger elements and control thereof takes place consecutively by reason of the fact that the lower dead-center point of one of the two piston parts or plunger elements is displaced in relation to that of the other piston part or plunger element which surrounds the former piston part or plunger member. By the displacement of the lower dead-center point of the outer piston part or plunger element, the volume of the compression space in the pump cylinder and consequently the quantity of fuel delivered with each pump stroke can be varied.

The outer piston part or plunger element is ring-shaped and accommodates therein the inner piston part or plunger element which is of circular cross section. The outer plunger element is provided with openings which serve as intake suction ports for the fuel to enter when they are uncovered during the downward movement of the outer plunger elements as soon as the outer plunger element leaves the guide member thereof and provided that the inner plunger element in its movement has also uncovered the intake ports and, therefore, no longer prevents admission of fuel to the inside of the outer plunger element.

The fuel is thereby located in the outer pump space and enters from this outer pump space through the intake ports into the compression space in which a vacuum has been created by the downward movement of the inner plunger element. When the lower dead-center positions of both plunger elements have been reached, which position is reached first by the outer plunger element, then the movement of the pump or plungers is reversed by the pump push rod.

The inner piston part or plunger element, which commences to move first, is so constructed in accordance with the present invention that upon actuation of the pump when the inner piston part is moved by the push rod into the guide bore of the cylinder thereof formed by the outer piston part or pump element, the inner piston part initially closes the intake ports in the outer piston

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part or plunger element, upon further movement effects a precompression of the fuel, and upon still further movement of the push rod together with the outer piston part or plunger element provides a reduction in the volume of the compression stroke which in turn effects further compression of the fuel and ultimate delivery thereof under pressure.

According to a further feature of the present invention, the movement of the outer piston part or plunger member which is limited in the downward direction by the lower dead-center point, may be realized by means of a special arrangement of the parts effecting such control. More particularly, in an arrangement according to the present invention, the displacement of the dead-center position of the outer piston part or plunger member is realized by a means of a control plate which abuts against a shoulder of the outer plunger member. Thus a change of the lower dead-center point of the outer plunger element is determined by the position of the control plate which abuts against the shoulder of the outer pump element from below. The control plate itself may be raised and lowered within certain limits whereby the lower dead-center position of the outer piston part or plunger element may be adjusted. The control plate is adjusted upwardly or downwardly by an eccentric cam forming part of a bolt which may be rotated by a lever.

The actuation of the push rods, which effect the movement of the pump pistons or plungers, is accomplished, for instance, by a cam or disk rotatable about the central longitudinal axis. The disk is provided with a surface which is inclined relative to a plane perpendicular to the axis of the disk on which surface the push rods are resiliently supported. By rotating the disk or cam, the push rods are consecutively raised and lowered in parallel to the center axis of the drum.

Accordingly, it is an object of the present invention to provide a fuel pump for internal combustion engines in which a plurality of pump units are arranged in such a way that operation thereof can be accomplished by a single cam thereby resulting in a compact unit.

It is a further object of the present invention to provide an injection pump for internal combustion engines which is simple in structure, reliable in operation, and which avoids possible interruptions or failures in the operation thereof as much as possible.

It is another object of the present invention to provide an injection device for internal combustion engines with which accurate metering of the fuel for a plurality of engines cylinders is accomplished by a single metering device of relatively simple structure that is reliable in operation.

Still another object of the present invention resides in the provision of an injection pump unit in which the individual pump pistons or plungers consist of two piston parts or plunger elements wherewith it is possible to produce precompression of the fuel in the pump compression space, fuel line and injection nozzle before actual injection commences which results in an accurately timed and vigorous start of injection.

A further object of the present invention resides in the fact that during the suction stroke of each pump a vacuum is created in the pump compression space, fuel line and injection nozzle which, in the first place, assures a prompt cut-off of fuel delivery at the end of injection thereby resulting in improved fuel economy, and which, in the second place, assures rapid filling of the pump compression space during the suction stroke of the plungers thereby improving the volumetric efficiency of the pump.

These and further objects, features and advantages of the present invention will become more obvious from the following description of a multi-plunger drum-type in-

jection pump in accordance with the present invention when taken in connection with the accompanying drawings which show, for purposes of illustration only, one preferred embodiment and wherein:

Figure 1 is a top view of a multi-plunger drum-type injection pump assembly according to the present invention incorporating four pump units, for example, for a four-cylinder engine;

Figure 2 is a cross-sectional view through the pump assembly taken along line 2—2 of Figure 1; and

Figure 3 is a cross-sectional view through the pump assembly taken along line 3—3 of Figure 1.

Referring now more particularly to the drawing wherein like reference numerals are used throughout the various views to designate like parts, the drum-type multi-plunger injection pump according to the present invention generally designated by reference numeral 1 consists of a pump housing 2 shown in the upper part of Figures 2 and 3 and of a control housing 3 arranged therebelow in coaxial relationship therewith. The partition or separating plate 4 forms the terminal wall between the pump housing 2 and the control housing 3. The seal between the pump chamber and the control chamber is realized herein in a special manner as will be explained more fully hereinafter. The drive of the pump or actuation of the push rods is accomplished by a cam disk 5 for the push rods which is provided with a surface inclined in relation to the horizontal or transverse plane. The cam disk 5 is rigidly connected with the shaft 6 and is driven thereby. The cam disk 5 and shaft 6 are supported in the flange housing 9 by means of needle bearing 7 and thrust bearing 8. The pump housing 2, the partition plate 4, the control housing 3 and flange housing 9 are held together by screws or bolts 10.

The actual compression space 11 is located within the cylinder 12. This cylinder 12 also serves as a guide for the up and down movement of the outer piston part or plunger 13. The compression space 11 is closed off at the lower end thereof by the outer piston part or plunger member 13 and by the inner piston part or plunger member 14, and at the upper end thereof by the fuel pipe connector nipple 15 and a closing plate arranged therebelow. The connector nipple 15 is provided with a bore 16 through which the fuel under pressure passes on to the combustion chamber of the engine cylinder.

In addition thereto an auxiliary fuel chamber or space 17 is provided in the inside of the pump housing 2 from which fuel passes through radial apertures or ports 18 arranged in the cylindrical wall of the outer plunger element 13 through the compression space 11. The control plate 19 serves for purposes of metering the required quantity of fuel which control plate 19 may be adjusted in an axial direction within certain limits by the eccentric cam 20. The cam 20 is part of the bolt 21 which may be rotated by a lever 22. The control disk 19 includes bores 23, the number of which corresponds to the number of pumping units. The bores 23 are large enough so that the smaller outer diameter 24 of the outer plunger element 13 can slide freely up and down therein, but they are smaller than the diameter 25 of the outer plunger element 13 so that the outer plunger element 13, in its downward movement toward push rod 28, is limited by the contact of its shoulder 26 with the abutment surface 27 of the control plate 19. By raising or lowering the control plate 19 by means of the eccentric cam 20, the lower dead-center or limiting position of the outer plunger element 13 is also adjusted and the volume of the compression space 11 for drawing in the fuel is thereby made smaller or larger. The adjustment of control plate 19 to select the lower dead-center or limiting position of plunger element 13 also determines the point of travel of plunger 14 at which the port 18 is closed during the compression stroke of push rod 28.

Operation

The operation of the multi-plunger drum-type injection pump according to the present invention is as follows:

The shaft 6 is rotated whereby the individual push rods 28 are consecutively raised and lowered by the inclined surface of the cam disk 5. The push rods 28 themselves are arranged in tappets 29. For transmitting the movement produced by the cam disk 5 to the tappets 29, special rollers are provided which are supported in bearing pins 30. The push rod 28 is shown in its uppermost position while the push rod 28' is shown in its lowermost position. From Figure 2 it is evident that the push rod 28 is surrounded by a cylindrical rubber spring 31 which serves at the same time as a seal as more fully described in my copending application Serial No. 648,008, filed March 25, 1957, entitled Injection Pump for Internal Combustion Engines.

Upon raising the push rod 28', which is sealed off by the rubber spring 31', the inner plunger element 14' is initially raised whereby the spring 32', which has the task of keeping the inner plunger element 14' in contact with the push rod 28', is compressed. During the upward movement of the inner plunger element 14', the port 18' through which the fuel has passed from the fuel chamber 17 is closed first. The fuel is supplied to the fuel chamber 17 through the pipe fittings 33 and 33' (Figure 1). While the ports 18' are closed, the further upward movement of the inner plunger element 14' into the compression space 11 first creates a slight precompression of the fuel. By further movement of the inner plunger element 14' into the outer plunger element 13' the lower edge of the inner plunger member 14 reaches a position of alignment with the lower edge of the outer plunger element 13'. From there on both the inner plunger element 14' as well as the outer plunger element 13' are raised together by the push rod 28' and not only the spring 32' but also the spring 34' which has the task to press the outer plunger element downwardly are compressed whereby the fuel in the compression chamber 11' is further compressed and supplied through the bore 16' to the combustion space.

The upper dead-center position of the two plunger elements 13 and 14 is shown on the right-hand side of Figure 2 with the springs 32 and 34 in a compressed condition and with the push rod 28 also in its uppermost position. From this uppermost position, the push rod 28 again moves downwardly. The outer and inner plunger elements 13 and 14 follow this movement until the outer plunger element with its shoulder 26 contacts the surface 27 of the control plate 19. It becomes clear that, by lowering and raising of the control plate 19, the compression chamber 11 can be increased or decreased whereby the fuel quantity drawn in for compression is increased or decreased. The inner plunger element 14 follows the push rod 28 to its lowermost position whereby the inner plunger element 14 again uncovers the ports 18 after leaving the guide portion of the cylinder 12 so as to enable the inflow of new fuel for the next cycle. After this, the cycle repeats itself. From the foregoing description of operation it is apparent that the concentric plunger elements of each pumping unit are actuated with mutually distinctive reciprocating movements by a single respective push rod 28.

While I have shown one preferred embodiment of my invention, it is understood that the same is not limited thereto but is susceptible of many changes and modifications within the scope of a person skilled in the art, and I intend to cover all such changes and modifications as encompassed by the appended claims.

I claim:

1. A multi-plunger injection pump for internal combustion engines comprising a pump housing and a plurality of pumping units arranged in said pump housing, actuating means including a drive shaft having cam

means and push rods operatively connected with said cam means for actuation of said pumping units within a predetermined stroke, each of said pumping units including an outer plunger element and an inner plunger element slidably mounted in said outer element, said plungers being mutually distinctively actuated by a respective push rod of said actuating means, cylinder means in said pump housing for slidably guiding said outer element therein and forming a compression space having outlet means, adjusting means including a control plate operatively connected with said outer element for adjusting the lower limiting position thereof in relation to said cylinder for varying the volume of said compression space, said outer plunger element being a hollow cylinder provided with inlet port means for said compression space, said inner plunger element being of cylindrical shape, only said inner plunger element being movable by means of said push rod during a first portion of its compression stroke to close said inlet port means while the movement of said push rod during the remainder of the stroke effects simultaneous movement of said inner and said outer plunger elements for compression and delivery of liquid from said outlet means.

2. A multi-plunger injection pump for internal combustion engines according to claim 1, wherein shoulders are provided on said outer plunger element for engagement with said control plate, and wherein said adjusting means includes a lever-operated cam.

3. A multi-plunger injection pump for internal combustion engines according to claim 1, wherein said pump housing is provided with a control space and a pump space sealed with respect to said control space, said two spaces being located one above the other, said cylinder means consisting of a plurality of essentially parallel cylinders.

4. A multi-plunger injection pump for internal combustion engines according to claim 1, wherein the means for actuating said pumping units includes a rotatable drive disk mounted on said drive shaft, an actuating surface on said disk being operatively connected to actuate said push rods, said actuating surface being inclined to a plane perpendicular of the axis of said shaft.

5. A drum-type injection pump for internal combustion engines comprising a pump housing and a plurality of pumping units arranged for movement in said pump housing, actuating means including a plurality of reciprocable push rods engageable with said pumping units for reciprocable actuation thereof, means including a rotatable cam for reciprocating said push rods, cylinder means in said pump housing for receiving and slidably guiding each said pumping unit and forming therewith a compression space having outlet means, each of said pumping units including an outer plunger element slidable within said outer plunger element, each of said plunger elements of a pumping unit being actuated mutually distinctively for reciprocating movement by a single push rod, said outer plunger element having inlet port means for said compression space, means defining a pump space around said inlet port means for supplying fuel to said compression space when said inlet port means is open, said inner plunger element closing said inlet port means during a first portion of a compression stroke of said push rod before said outer plunger element is actuated by the push rod, control means for adjusting the outer one of said plunger elements relative to said push rod including adjustable abutment means engageable with said outer plunger element to define a limiting position for the part of the reciprocating movement of said plunger element in the direction toward said push rod and to thereby determine the position of the push rod at which said inlet port means is closed during a compression stroke of the push rod, said plunger elements being actuated by said push rod during a subsequent portion of its compression stroke to compress fuel in said com-

pression space for discharge from said outlet means for injection into an engine.

6. A drum-type injection pump according to claim 5, wherein said two plunger elements are concentric with respect to each other with the inner plunger element relatively slidable within the outer annular plunger element, and wherein each outer plunger element is provided with a generally cylindrical wall having radial aperture means therein constituting said inlet port means to enable the inflow of fuel from said pump space into the compression space formed partially within the outer plunger element.

7. A drum-type injection pump according to claim 5, wherein said two plunger elements of each pumping unit are concentric plunger elements, and wherein said actuating means is operative to initiate movement of the two plunger elements of a respective pumping unit consecutively during a compression stroke of the respective push rod.

8. A drum-type injection pump according to claim 7, wherein the outer one of said concentric plungers of each pumping unit is provided with a generally cylindrical wall having radial apertures constituting said inlet port means to enable the passage therethrough of fuel to said compression space, and wherein said actuating means is operative to initially move the inner plunger member relative to the corresponding outer plunger member thereof to close said inlet port means, thereafter providing pre-compression of the fuel thus trapped within the compression space, and thereupon effect together with said outer plunger member compression and supply of the fuel to said engine.

9. A drum-type injection pump according to claim 8, wherein said actuating means includes a disk-like element rotatable about its axis with a driving surface thereof inclined relative to a plane perpendicular to said axis, and means for operatively connecting said push rod means with said driving surface.

10. A drum-type injection pump according to claim 9, wherein said control means includes a control plate for varying the dead-center position of each outer plunger member to vary the amount of injected fuel.

11. A multi-plunger injection pump for internal combustion engines comprising a pump housing portion, a control housing portion, a plurality of pumping units arranged within said pump housing portion for pumping liquid, actuating means operatively connected with said pumping units for actuation thereof including a drive shaft and push rods, an operating control chamber formed in said control housing portion, a pump chamber in said pump housing portion, said chambers being arranged one above the other, sealing means arranged between said chambers, each of said pumping units including an outer plunger element and an inner plunger element slidably mounted in said outer element and operated separately from each other, cylinder means in said pump housing portion for slidably guiding said outer element therein including outlet means, adjusting means in said pump housing portion including a control plate operatively connected with each said outer plunger element for adjusting the lower dead center position thereof in relation to said cylinder for varying the volume of said compression space and therewith delivery of liquid, shoulders provided on said outer plunger element for engagement with said control plate, said adjusting means including a lever-operated cam.

12. A drum type injection pump for internal combustion engines comprising a pump housing, said pump housing being provided with cylinder means including outlet means, piston means in said cylinder means, each of said piston means including two relatively movable piston parts consisting of two concentric plunger members, actuating means operatively connected with said piston means for reciprocation thereof in said cylinder means for supplying fuel to the engine by said pump,

control means operatively connected with the outer one of the two plunger members of each piston means for adjusting the quantity of fuel supplied during the compression stroke of the respective piston means, said actuating means being operative to reciprocate the two piston parts of a respective piston means with mutually distinct reciprocating movements, the outer one of said concentric plungers of each piston means being provided with aperture means to enable the passage therethrough of fuel, means in said housing defining a chamber about said aperture means, said actuating means being operative to initially move the inner plunger member relative to the corresponding outer plunger member thereof to close said aperture means, thereafter providing pre-compression of the fuel thus trapped within the compression space formed within said outer plunger member, and thereupon effect, together with said outer plunger member compression and supply of the fuel, said actuating means including a disk-like element rotatable about its axis with the surface thereof inclined relative to a

plane perpendicular to said axis, said control means including means for varying the limiting position of movement of each outer plunger member in one direction to vary the amount of injected fuel, said actuating means further including tappet means in driven engagement with the disk-like element, push rod means actuated by said tappet means, and rubber spring means simultaneously constituting a seal and spring intermediate said chamber defining means and said push rod means, said rubber spring means having opposite ends respectively abutting said two last-mentioned means.

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