June 6, 1967 J. R. GIRAUDON 3,323,505

FUEL INJECTION PUMPS HAVING A ROTATING DISTRIBUTING VALVE

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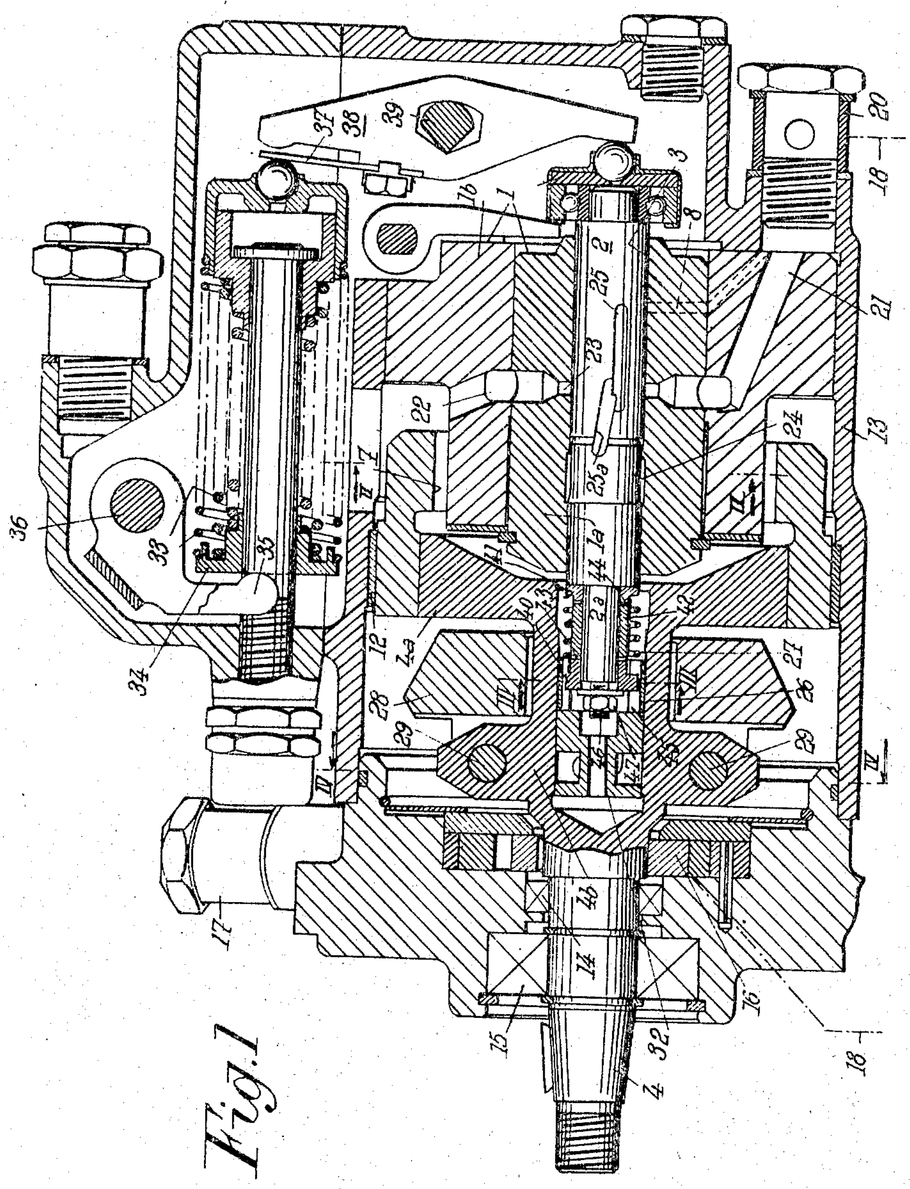

Fig.1

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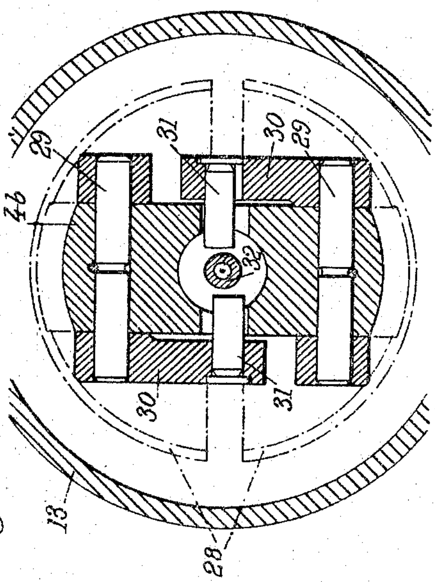

Fig. 4.

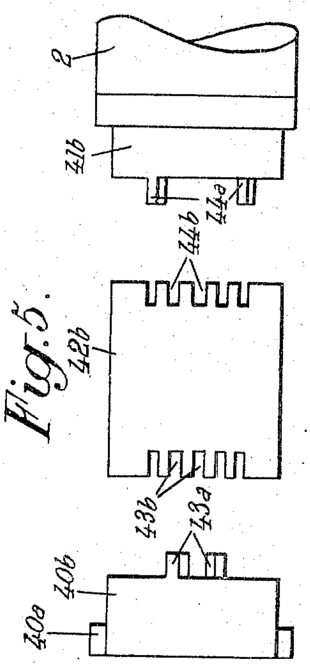

Fig. 5.

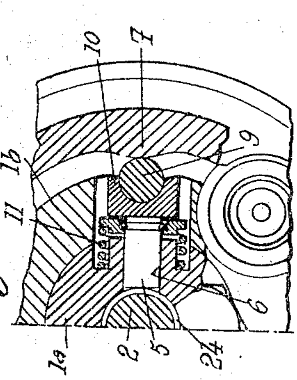

Fig. 2.

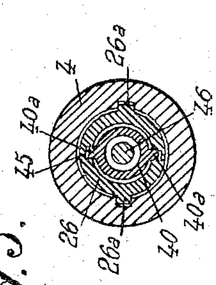

Fig. 3.

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FUEL INJECTION PUMPS HAVING A ROTATING DISTRIBUTING VALVE

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3 Claims. (Cl. 123—139)

The present invention relates to a fuel injection pump for a multicylinder internal combustion engine, said pump comprising a fixed body and, inside said fixed body a rotating distributing valve driven by a shaft itself driven by the engine and substantially coaxial with said distributing valve, such a pump further comprising at least a pump piston reciprocable, in a bore provided in one of the two elements constituted by the fixed body and the driving shaft, under the action of a cam carried by the other of said two elements, the fixed body being provided with distribution conduits leading to the engine injectors and cooperating with distribution passages carried by the rotating distributing valve and adapted to communicate with said bore. The invention is more especially, but not exclusively, concerned with pumps of this type wherein the distributing valve is arranged in such manner as to reduce the rate of delivery of the pump when said rotary valve is given a translatory movement and wherein a centrifugal regulating device responsive to the speed of revolution of the engine is adapted to control this distributing valve, with respect to its driving shaft, first in rotation (variation of the advance to injection) then in translation (variation of the rate of injection) in response to variations of the speed of the internal combustion engine.

The object of the present invention is to provide a pump of this kind which is better adapted to meet the requirements of practice than those existing at the present time concerning the construction of the joint interposed between the internal combustion driving shaft and the distributing valve of the pump.

According to the present invention, said joint comprises a driving element consisting of a first sleeve rotating together with the driving shaft, a driven element consisting of a cup-shaped member rotating together with the distributing valve and an intermediate sleeve interposed between said first sleeve and said cup-shaped member the adjoining edges of the first sleeve and of the intermediate sleeve, respectively, being interlocked by means of cooperating sets of teeth disposed circularly with a first angular interval from one tooth to the next one whereas the adjoining edges of the intermediate sleeve and of the cup-shaped member, respectively, are interlocked by means of cooperating sets of teeth disposed circularly with a second angular interval from one tooth to the next one, said interval being different from the first mentioned interval, which permits of adjusting the angular position of the driving member with respect to the distributing valve by varying the relative setting of the teeth engaged together, the means for transforming the translatory movement of the distributing valve into a movement of rotation thereof with respect to the driving shaft being advantageously interposed between said shaft and said driving member.

A preferred embodiment of the present invention will be hereinafter described with reference to the appended drawings, given merely by way of example, and in which:

FIG. 1 is an axial sectional view of a fuel injection pump made according to the present invention;

FIG. 2 is a sectional partial view on the line II—II of FIG. 1;

FIG. 3 is a cross sectional view on the line III—III of FIG. 1;

FIG. 4 is a cross sectional view on the line IV—IV of FIG. 1.

FIG. 5 shows, on an enlarged scale, a modification of a detail of FIG. 1, the elements being shown separately.

The fuel injection pump illustrated by the drawings comprises a fixed body 1, preferably made of two coaxial pieces 1*a* and 1*b*, and a distributing valve 2 rotating in a cylindrical bore 3 provided in body 1, said valve 2 being driven in rotation by a shaft 4 itself driven by the internal combustion engine (not shown by the drawings) fed with fuel by the pump.

Two opposed pump pistons 5, only one of which is illustrated by the drawings (FIG. 2 thereof), are slidable, in respective cylinders 6 substantially perpendicular to the common axis of distributing valve 2 and shaft 4, under the action of an annular cam 7 including as many inward projections as the internal combustion engine comprises cylinders to be fed successively with fuel.

Cylinders 6 are placed in communication with the injectors of the internal combustion engine through conduits 8 provided in body 1. Annular cam 7, carried by a disc-shaped portion 4*a* integral with driving shaft 4, gives pistons 5 their reciprocating radial movements in cylinders 6 through rollers 9 and push-pieces 10, against the action of return springs 11. Cam 7 is journalled, through a bearing 12, in a casing 13 through the end wall of which shaft 4 extends, with the interposition of packing means 14, said end wall carrying a thrust ball bearing 15 for shaft 4.

In order to feed fuel to cylinders 6, there is provided in casing 13 a feed pump 16 the suction of which communicates with an inlet connection 17. The delivery of this pump 16 communicates through a pipe 18 with a connection 20 adapted in a removable manner to casing 13. This connection is in permanent communication, through a conduit 21 and an annular groove 22 provided in body 1, with equidistant radial holes 23, the number of which is equal to the number of the internal combustion engine cylinders, which holes 23 open into bore 3 opposite a first longitudinal groove (not visible on the drawings) provided in distributing valve 2, this first longitudinal groove opens into a peripheral annular groove 24 provided in distributing valve 2 and in permanent communication with pump cylinders 6.

The delivery circuit from said pump cylinders 6 comprises a second longitudinal groove 25 starting from annular groove 24 and leading to delivery passages 8.

It will be understood that fuel injection begins when a hole 23 ceases to be in communication with the second longitudinal groove 25 and that it is cut off just when the next hole 23 is placed in communication with the first longitudinal groove.

There is provided a regulating device capable of varying the angular and longitudinal positions of distributing valve 2 with respect to driving shaft 4.

Variation of the angular position of said distributing valve 2 with respect to shaft 4 offsets, in the cycle of operation, the period for which no radial hole 23 communicates with both of the longitudinal grooves of distributing valve 2, that is to say varies the advance to injection, whereas variation of the longitudinal position of distributing valve 2 varies the flow rate of the pump per revolution if said longitudinal grooves are provided with inclined portions, such as 25*a*, oblique in opposed directions with respect to the axis of distributing valve 2 and located opposite radial holes 23.

For this purpose, there is provided a regulating device capable of exerting an axial force, variable in the same manner as the speed of rotation of shaft 4, upon a cylindrical member 26 capable of sliding without rotating with respect to shaft 4, against the action of a spring **27**, while imparting a helical movement to distributing valve **2** through means which will be hereinafter described. This member **26** is subjected, on the one hand, to the action of said force, and on the other hand, in the opposed direction, to the action of return means adjustable through a forked lever **35**.

The regulating device comprises two masses **28** pivoted about two respective axes **29** carried by an annular projection **4*b*** of shaft **4**, each of said masses **28** carrying an arm **30** (FIG. 4), which will be hereinafter referred to, and which serves to produce, through a spindle **31**, a longitudinal movement of member **26** serving to control distributing valve **2**, against the action of spring **27**.

With such a regulating device the angular position of distributing valve **2** with respect to shaft **4** will depend upon the force exerted by masses **28**, this force depending itself upon the speed of revolution of the internal combustion engine. Furthermore, the axial position of distributing valve **2** with respect to shaft **4** will depend not only on said force but also on the position of lever **35**.

Preferably, as shown, the return means above referred to consists of a set of springs **33** the end of which opposed to that connected to distributing valve **2** bears upon a cup-shaped member **34** movable in response to the movements of the throttle valve of the internal combustion engine, for instance by the provision of forked lever **45** fixed on the spindle **36** of the throttle valve. As for the other end of this set of springs **33**, it acts upon distributing valve **2** through a resilient plate **37** carried by a lever **38** pivoted about an axis **39** and interposed between distributing valve **2** and the set of springs **37**.

Such a pump works as follows:

When shaft **4** revolves together with cam **7**, pistons **5** are alternately pushed outwardly (suction) under the action of springs **11** and inwardly (delivery) when rollers **9** run along the bosses of cam **7**. During the suction periods, the fuel under pressure in annular groove **22** passes through holes **23**, located opposite the longitudinal grooves of distributing valve **2** and said fuel comes to fill up the volumes resulting from the outward movements of pistons **5** in cylinders **6**. During the delivery periods, fuel is delivered into annular groove **24** and the longitudinal grooves of the distributing valve. As long as one of the holes **23** is cleared by longitudinal groove **25**, fuel is discharged through this hole into annular groove **22** and there is no injection. As soon as distributing valve **2**, which rotates at the same speed as cam **7**, has covered this hole by its inclined groove **25*a***, the fuel delivered by pistons **5** passes through groove **25** and through that of passages **8** which is located opposite this last mentionel groove and thus reaches the corresponding engine injector. Thus injection takes place until the other longitudinal groove of distributing valve **2**, the inclined portion of which is inclined in a direction opposed to that of inclined portion **25*a***, clears the next hole **23**. Therefore the inclined portions related to the two longitudinal grooves of the distributing valve determine the beginning and the end of injection respectively, the regulating device determining the beginning of injection in every cycle of the pump and the rate of injection of the pump.

In order to have the delivery rate of the pump uninfluenced by variations of the advance to injection, pistons **7** must move with a constant velocity for a constant speed of revolution of cam **7**.

The object of the present invention is to permit an adjustment of the angular position of distributing valve **2** with respect to cam **7** such that, within the limits of said adjustment, injection always takes place for a displacement of pistons **5** within which, for all possible speeds of revolution of the internal combustion engine, the velocity of movement of said pistons **5** depends only upon said engine speed.

For this purpose, according to the present invention the joint interposed between cylindrical member **26** and distributing valve **2** comprises a driving element consisting of a sleeve **40** revolving together with shaft **4**, a driven element consisting of a cup-shaped member **41** fixed with respect to distributing valve **2**, and an intermediate sleeve between said first sleeve **40** and said cup-shaped member **41**, the adjoining faces of sleeve **40** and of intermediate sleeve **42** carrying cooperating teeth **43** forming a circular row with a first angular interval between them, whereas the adjoining faces of intermediate sleeve **42** and cup-shaped member **41** carry cooperating teeth **44** forming another circular row with a second angular interval between said last mentioned teeth different from the above mentioned interval.

Cylindrical member **26** is provided with two longitudinal ribs **26*a*** slidable, respectively, in two grooves provided in shaft **4** and parallel to the axis of said shaft whereby member **26** can slide without rotating with respect to shaft **4**. In order to transform the translatory movement of distributing valve **2** produced by the regulating device into a movement of rotation about the axis of shaft **4**, two lugs **40*a*** are provided on sleeve **40** and slidably engaged in two helical grooves **45** provided in member **26**. Finally in order to secure the whole of sleeve **40** and of intermediate sleeve **42** to distributing valve **2**, the end of said valve **2** carries a threaded rod **46** on which is mounted a nut **47** applied against the end wall of sleeve **40**. Cup-shaped member **41** is fixed, for instance by welding, to distributing valve **2**. A spring **27**, freely surrounding sleeve **40** and intermediate sleeve **42**, bears at one end against piece **26** and at the other end against cup-shaped member **41**.

According to the embodiment of FIG. 1, the sets of teeth **43** and **44** are provided on the whole periphery of elements **40**, **41**, and **42**. The respective numbers of the teeth of these sets of teeth (which teeth advantageously consist of ribs), preferably differ by one. For instance these numbers are **24** for set **43** and **25** for set **44**.

According to the modification of FIG. 5, where the first mentioned sleeve is designated by **40*b***, the cup-shaped member by **41*b*** and the intermediate sleeve by **42*b***, there are only two teeth or projections, respectively **43*a*** and **44*a*** upon sleeve **40*b*** and cup-shaped member **41*b***, whereas notches **43*b*** and **44*b***, formed in intermediate sleeve **42*b***, extend over portions only of the periphery of said sleeve **42*b***, symmetrical respectively with respect to each other. Ribs **43*b*** are at 15° from one another and ribs **44*b*** are at 16° from one another.

The joint thus obtained permits, after loosening of nut **47**, of adjusting the angular position of distributing valve **2** with respect to shaft **4** with a very high accuracy, by a suitable choice of the hollows and teeth **43**, **44** or **43*a***, **43*b***, **44*a***, **44*b*** engaged in one another. In the numerical examples above stated, in the case of FIG. 1 the adjustment is effected by steps corresponding to multiples of an angle equal to the difference between 360°/24 and 360°/25, that is to say by steps corresponding to three fifths of a degree whereas in the construction according to FIG. 5 the adjustment is effected by steps corresponding to one degree.

In a general manner, while the above description discloses what is deemed to be a practical and efficient embodiment of the present invention, said invention is not limited thereto as there might be changes made in the arrangement, disposition and form of the parts without departing from the principle of the invention as comprehended within the scope of the appended claims.

What I claim is:

1. For use in connection with an internal combustion engine, a fuel injection pump for said engine which comprises, in combination,

a fixed body,

a driving shaft operative by said internal combustion engine and rotatable in said body about an axis, said shaft being provided with an axial cylindrical recess in the wall of which are formed two grooves parallel to the shaft axis,

one of the two above mentioned parts being provided with at least one bore radial with respect to said axis,

a piston slidable in said bore,

a cam rigid with the other of said two first mentioned parts operatively connected with said piston for controlling the reciprocating movement thereof in response to the rotation of said two parts with respect to each other,

a distributing valve rotatable in said body and substantially in line with said shaft,

said distributing valve being provided with distribution passages adapted to communicate with said bore,

said fixed body being provided with fuel distributing conduits adapted to communicate with said distribution passages,

a joint for coupling together said shaft and said distributing valve, said joint including,

a driving structure comprising a cylindrical member provided, externally, with two longitudinal ribs slidable, respectively, in said grooves, whereby said cylindrical member can slide without rotating with respect to said shaft, said cylindrical member being provided in its inner face with two helical grooves, and a first sleeve coaxially disposed in said cylindrical member and including two external lugs slidable in said helical grooves,

a driven element consisting of a cup-shaped member rigidly fixed to said distributing valve,

an intermediate sleeve interposed between said first sleeve and said cup-shaped member coaxially therewith,

two cooperating sets of teeth disposed circularly along the adjoining edges of the first sleeve and of the intermediate sleeve, respectively, with a first angular

interval from one tooth to the next one, for interlocking said first sleeve and said intermediate sleeve together, and

two cooperating sets of teeth disposed circularly along the adjoining edges of the intermediate sleeve and of the cup-shaped member, respectively, with a second angular interval from one tooth to the next one, for interlocking said intermediate sleeve and said cup-shaped member together, said second interval being different from the first mentioned interval,

whereby the angular position of said driving shaft with respect to the distributing valve can be adjusted by varying the relative setting of the teeth engaged together, and

means, between said driving shaft and said driven sleeve, for transforming the translatory movement of said distributing valve into a movement of rotation with respect to said shaft.

2. A fuel injection pump according to claim **1** wherein the sets of teeth extend along the whole edge of said first sleeve, of said intermediate sleeve and of said cup-shaped member.

3. A fuel injection pump according to claim **1** wherein only two teeth or projections are provided on the first sleeve and on the cup-shaped member, whereas notches formed in the intermediate sleeve extend over portions only of the periphery of said intermediate sleeve.

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