Nov. 20, 1962 W. STAEGE ET AL 3,064,579

FUEL INJECTION PUMP FOR INTERNAL COMBUSTION ENGINES

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Fig. 1

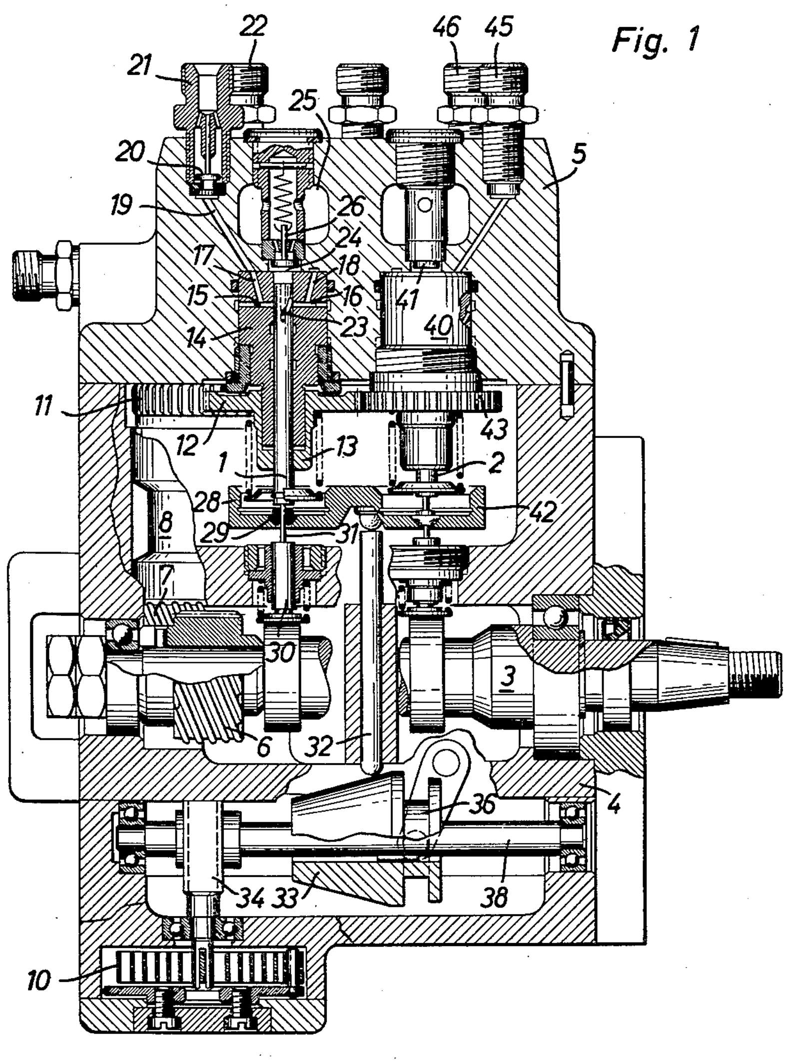

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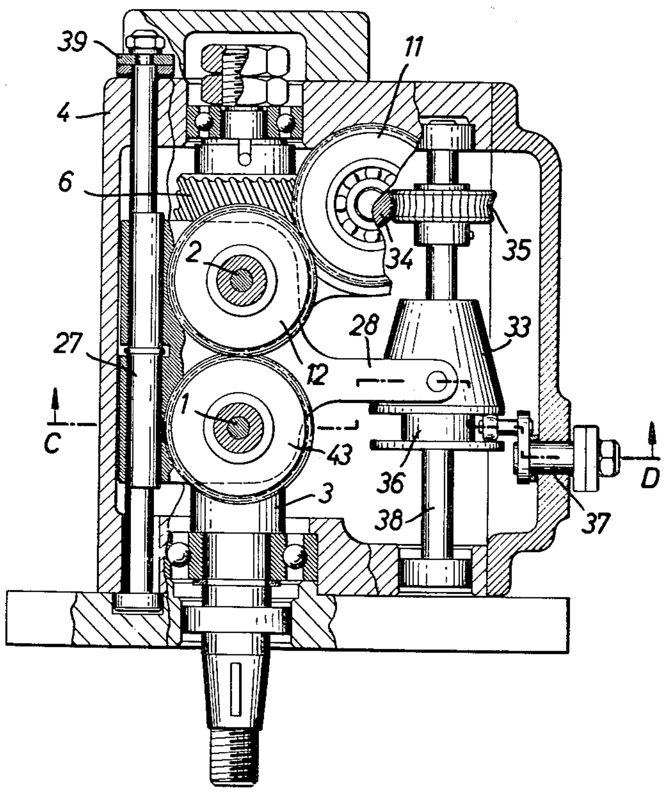
Fig. 2



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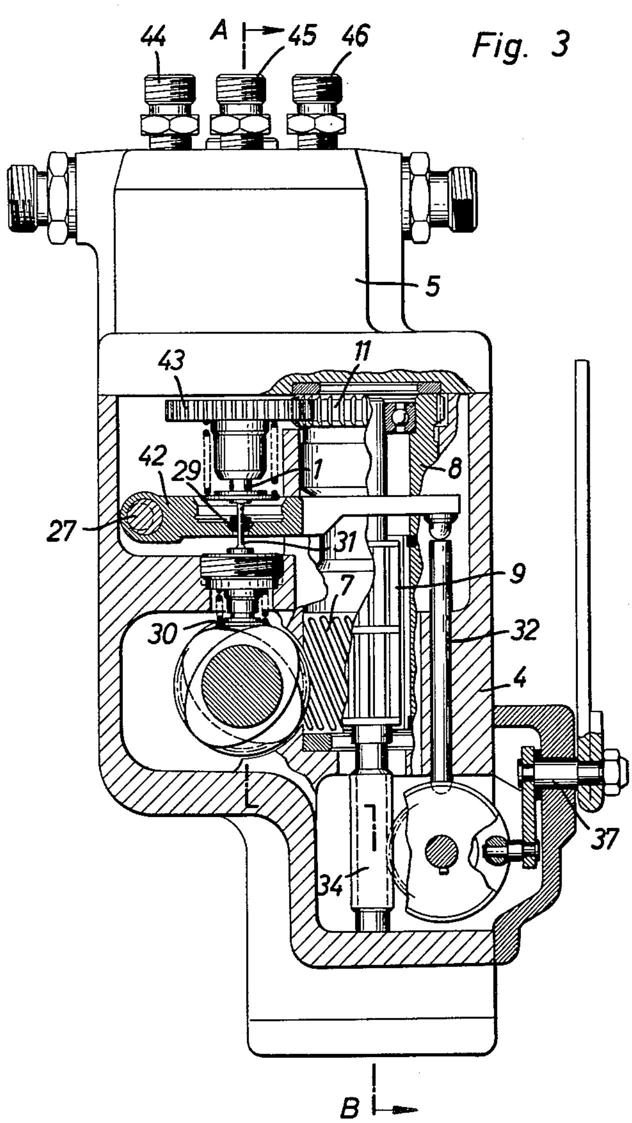

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United States Patent Office

3,064,579

Patented Nov. 20, 1962

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3,064,579
FUEL INJECTION PUMP FOR INTERNAL COMBUSTION ENGINES

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Filed Apr. 7, 1959, Ser. No. 804,775
Claims priority, application Germany Sept. 17, 1958
6 Claims. (Cl. 103—2)

The present invention relates to fuel injection pumps for internal combustion engines.

According to a known method of control, the quantities of fuel delivered during every stroke by a fuel injection pump serving to feed fuel to an internal combustion engine can be controlled by varying the length of stroke of a pump plunger which is operated by a rotary cam. In fuel injection pumps operating on this principle, the arrangement is such that the starting position of the pump plunger before the commencement of a delivery stroke is determined by the setting of a control linkage. The setting of the said linkage is in turn determined by controlling factors which depend in a predetermined manner on the decisive operational characteristics of the internal combustion engine with which the fuel injection pump is associated.

In view of the severe conditions under which fuel injection pumps of the type indicated have to operate when used in automotive vehicles, these pumps must be of extremely dependable construction To provide for the required dependability in operation, it is the best practice to design the fuel injection pump in such a manner as to form the most compact unit possible.

In a fuel injection pump for an internal combustion engine provided with a distributor which is associated with a plurality of cylinders, which distributor operates on the movable-piston principle and being designed to effect the distribution through rotary movements of the piston member, the delivery of fuel being effected by longitudinal displacement of the piston or plunger, the problem indicated earlier is solved, according to the present invention, by the provision, between the branching-off point serving to produce the said longitudinal movement and the means serving to transmit the rotary movements, of a speed pickup which is adapted to influence the length of the suction stroke of the plunger by way of a three-dimensional cam body. Thus, according to the invention, a distributor-type pump is provided which combines the required dependability and the desired compact arrangement.

Where the said speed pickup comprises a short-circuited annular rotor and a concentrically disposed internal armature carrying permamagnetic poles, the torque of the pickup, which is a function of the speed being balanced by a suitable energy storing means, it is possible, also according to the invention, to provide for the said annular rotor to effect the transmission of the rotary motion of the plunger at the point where this motion is introduced. Thus, for the purpose of obtaining a construction of minimum bulk, a member which is essential to the functioning of the pump is also used as a power-transmitting member so as to serve a plurality of functions.

Where the said speed pickup is designed in the aforementioned manner to operate electro-magnetically, it is further possible according to the invention to provide for the said internal armature to control the length of the suction stroke of the pump plunger or plungers by adjusting the said three-dimensional cam. According to another aspect of the invention, the said three-dimensional cam may be disposed on a spindle which extends

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parallel to the drive shaft of the pump, and the adjustment of the cam may be effected by way of a worm wheel drive through a drive shaft extending parallel to the axis or axes of the plunger or plungers.

Other objects and features of the invention will become apparent as the description proceeds, especially when taken in conjunction with the accompanying drawing illustrating a preferred embodiment of the invention. The fuel injection pump shown in the drawing comprises two pump plunger units arranged in side-by-side relationship, the second of the two units being driven directly via the first unit from the said speed pickup, the transmission of drive power being effected in a manner dealt with further below.

FIG. 1 is a vertical sectional view, partly in elevation, along the line A—B in FIG. 3 of the preferred embodiment.

FIG. 2 is a transverse sectional view.

FIG. 3 is another vertical sectional view along the line C—D of FIG. 2.

As will be seen in FIGS. 1 to 3, the pump plungers 1 and 2 are axially driven by the cams of the camshaft 3. These components of the fuel injection pump are indirectly supported by a casing which substantially comprises a box-like member 4 and an upper member 5 mounted on the top of the member 4.

A helical gear 6 mounted on the camshaft 3 drives another helical gear 7 which latter forms a structural unit with the annular rotor 8 of a speed pickup, the latter also comprising an internal armature 9 carrying permamagnetic pole pieces and being disposed concentrically with the said annular rotor; the torque of the armature, which is a function of its speed, is balanced by suitable energy storing means in the form of a spiral spring 10. The annular rotor 8 has also fixedly secured thereto a gear wheel 11 which is in driving engagement with a gear wheel 12 having a sleeve-like hub portion 13 which engages a flattening at the bottom end of the plunger 1 so as to transmit rotary motion to the plunger. The latter is guided by the barrel 14. Provided in the said barrel are as many transverse passages 15 and 16 as there are cylinders which are to be supplied with fuel by the plunger 1 of the injection pump element under consideration. The displaced fuel flows through inclined passages 17 and 18 within the barrel 14 and through communicating passages such as indicated at 19 which are provided in the upper casing member 5, further via a delivery valve 20 to a pipe union 21 to which the fuel injection line leading to the respective cylinder is fitted. FIG. 1 shows one additional union 22 which belongs to four such unions required for an injection pump serving a four-cylinder internal combustion engine. The axial arrangement of the plunger 1 in the upper casing member 5, in combination with the shown orientation of the passages 15 to 18 in the barrel 14, makes it possible to arrange the passages leading to the pipe unions such as 21, i.e. the passages 19 etc., at an angle to the plunger axis rather than transversely thereof. This enhances a smooth flow of the fuel delivered by the pump element, as the fuel flow does not undergo any major changes in direction. Since the barrel 14 is press-fitted against the inner end face of the bore in the upper casing member 5 receiving the barrel, a perfect sealing action is obtained around the point at which the inclined passage 17 merges into the passage 19. The aforementioned rotary motion of the plunger 1 which is derived from the sleeve-like hub portion 13 provides for the four pipe unions, e.g. the pipe unions 20 and 22, to be singly and consecutively placed in communication with the interior 24 of the pump barrel via the transversely drilled passage 23 extending through the plunger 1. Thus, the light oil to be used as a fuel which enters the pump barrel via the chamber 25 from which it may be drawn into the space 24 through the valve 26 is delivered during every delivery stroke of the plunger 1 to one of the four cylinders of the internal combustion engine, the number of the cylinder to which the fuel is delivered being determined by the rotary or angular position of the sleeve-like member 13.

The starting bottom dead center positions of the various plungers 1 can be adjusted by means of a rocker 28 which is supported for pivotal movement by a spindle 27. The rocker 28 enables the free bottom end of the plunger 1 when in its lower or starting position to rest on the portion 29 of the rocker so that the plunger drive tappet 30 during its downward movement may be disengaged from the lower end face of the plunger. It is only during the upward movement of the tappet 30 that the tappet through the medium of a pin 31 which is rigidly secured to the tappet can reengage the plunger, the point of engagement being determined by the position of the rocker. The position of the rocker is in turn determined by the co-operation of a tracer pin 32 with the three-dimensional cam body 33. The cam 33 is operated in accordance with the speed of the internal combustion engine by the speed pickup 8 acting through its permanently magnetic armature 9, the worm 34 connected thereto, and the worm wheel 35 driven by the said worm. In addition, the cam groove 36 which cooperates with a bell-crank lever 37 permits the cam 33 to be displaced along the shaft 38, the position of the cam on this shaft being varied in accordance with the operation of the accelerator pedal and thus in accordance with the position of the throttle valve as selected by the driver of the vehicle. Furthermore it is possible to vary the position of the rocker 28 by means of the element 39 shown in FIG. 2; this element permits the eccentric spindle 27 to be rotated in its bearing so that the position of the rocker can be changed.

Disposed parallel to the pump unit containing the plunger 1 is the pump element comprising the plunger 2; the barrel 40, the suction valve 41 and the rocker 42 of the second pump element are identically constructed with the corresponding elements of the first pump element. The system of elements associated with the plunger 2 is driven from the gear wheel 12 of the first unit through a gear wheel 43. The second pump unit which operates in unison with the first unit serves to feed four further cylinders of the internal combustion engine through four pipe unions including the unions 44 to 46 shown in FIG. 3.

In the embodiment illustrated in FIGS. 1 to 3, the rockers 28 and 42 form an integral component part. However, it would be possible to separate the rocker 28 associated with plunger 1 from the rocker 42 associated with plunger 2. This would permit the second pump unit to be put out of operation, while the first unit continues to deliver fuel to the engine.

What is claimed is:

1. An injection pump for an internal combustion engine comprising a pump housing, a pump cylinder in said housing, a plunger reciprocably and rotatably mounted in said cylinder, means to connect said cylinder to a plurality of engine cylinders, means to distribute fuel from said pump cylinder to said engine cylinders and to effect fuel delivery responsive to reciprocating and rotative movement of said plunger, a cam shaft in said housing, gearing means arranged between the plunger and said cam shaft and rotating the plunger responsive to rotation of the cam shaft, a cam on the cam shaft arranged to reciprocate the plunger responsive to such rotation, a rocking lever pivoted in the housing and located to adjust the bottom starting position of said plunger and thereby the quantity of fuel delivered during each stroke of said plunger, a rotatable and axially movable three-dimensional cam mounted in the housing, means acting between said last-named cam and said lever to adjust the angular position of said lever, a speed sensing device, said speed sensing device including an annular rotor formed with gears which are included in said gearing means, whereby the speed sensing device is directly coupled to said gearing means, means drivingly connecting said speed sensing device to said last-named cam to rotate same in accordance with the speed of the cam shaft, and additional means to move the three-dimensional cam axially.

2. An injection pump for an internal combustion engine comprising a pump housing, a pump cylinder in said housing associated with and adapted to be connected to a plurality of engine cylinders, a plunger reciprocably and rotatably mounted in said pump cylinder, means to distribute fuel from said pump cylinder to the engine cylinders responsive to the rotation of the plunger, means effecting fuel delivery response to the reciprocation of the plunger, a cam shaft, gearing means operatively coupling said cam shaft to said plunger to impart rotary movement thereto, cam means integral with said cam shaft and operatively coupled to said plunger to effect reciprocation thereof, a rocking lever pivotally mounted within said pump housing and operatively coupled to said plunger to determine its bottom starting position and the quantity of fuel delivered with each plunger stroke, a further cam shaft mounted within said pump housing, a cam mounted on said last-named shaft and having a three-dimensional surface integral therewith, means operatively coupling said rocking lever to said last-named cam to determine the angular position of the lever as a function of the rotated position of the three-dimensional surface, a speed sensing device, said speed sensing device including an annular rotor formed with gears which are included in said gearing means, whereby the speed sensing device is directly driven by said gearing means, and means coupling said speed sensing device to said last-named shaft to control its rotated position.

3. In a fuel injection pump as defined in claim 2, in which said speed sensing device comprises a short-circuited annular rotor mounted within said pump housing, an internal armature concentrically disposed relative to said annular rotor and having a plurality of permamagnetic pole pieces, and energy storing means coupled to said internal armature, so that the torque of said speed sensing device, which is a function of the speed, is balanced by said energy storing means.

4. A fuel injection pump as defined in claim 3, in which said internal armature is coupled to said three-dimensional cam to operate it as a function of the speed of the engine to influence the length of the suction stroke of said plunger.

5. A fuel injection pump as defined in claim 4, in which said further shaft supporting said three-dimensional cam is mounted within said pump housing parallel to said first-named cam shaft, gear means fixed on said further cam shaft, and a drive shaft connected to said internal armature and having a gear mounted thereon engaging said gear means.

6. An injection pump as defined in claim 5, wherein a control crank member is coupled to said three-dimensional cam to displace it along the axis of said cam shaft.

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