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[54] **FUEL INJECTION PUMP**

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[52] **U.S. Cl.** ..... **123/139 AC;** 123/139 AC

[51] **Int. Cl.** **F02m 39/00**

[58] **Field of Search** 123/139 AC, 139 AA, 139 AR, 123/139 AE, 139 AD

[56] **References Cited**

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[57] **ABSTRACT**

The invention relates to a fuel injection pump including an aperture pad mounted for sliding motion within the pump casing and interposed between a plunger piston and a tappet. Each hole of the pad is provided with an individual valve opening automatically during the upward motion of the pad through the force of inertia due to the acceleration of the pad and by the air compression within a space defined above the pad, and closing automatically during the downward motion of the pad for providing a vacuum through suction or drawing into this space.

4 Claims, 3 Drawing Figures

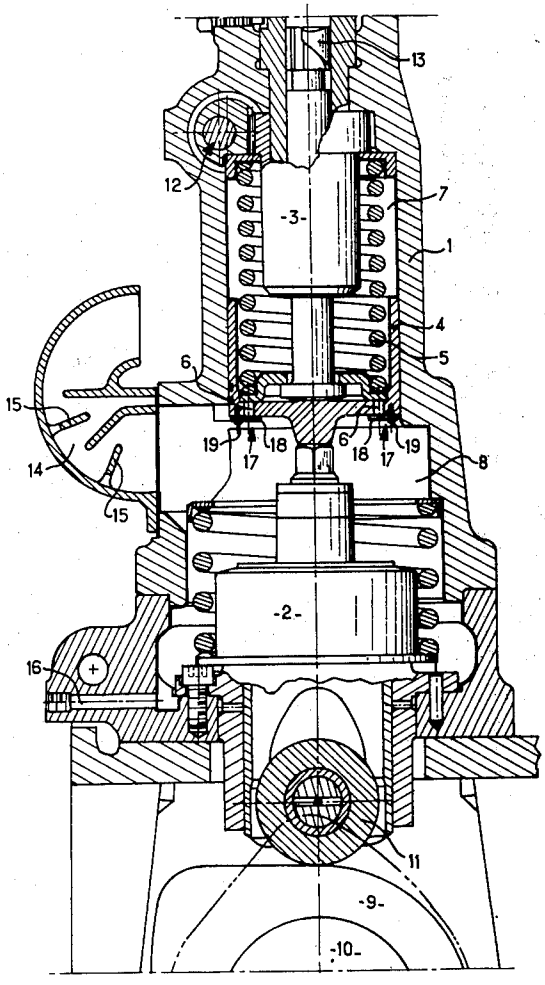

Fig: 1.

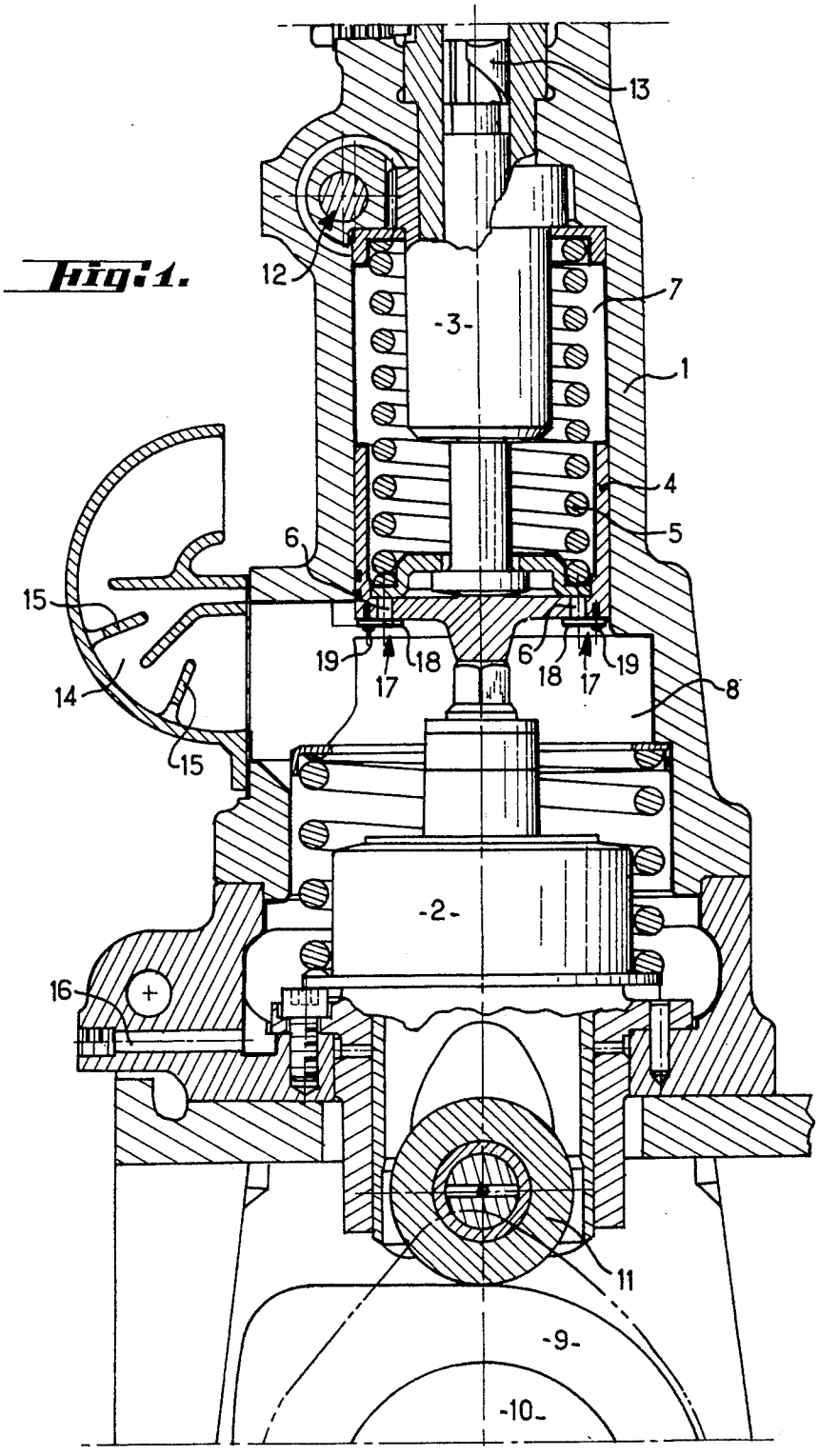

Fig: 2.

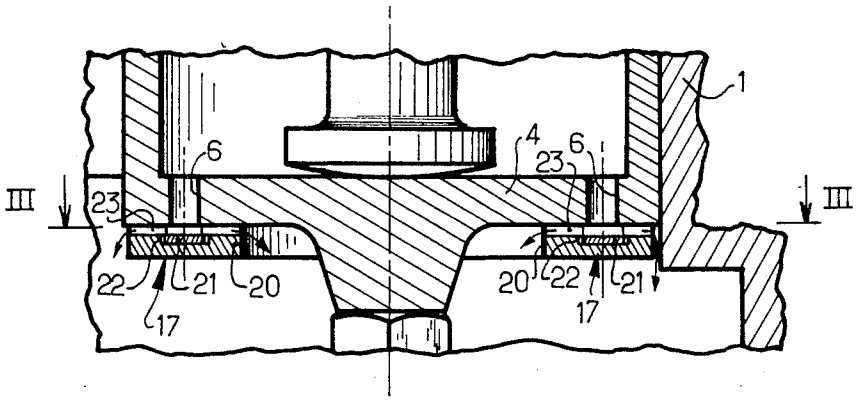
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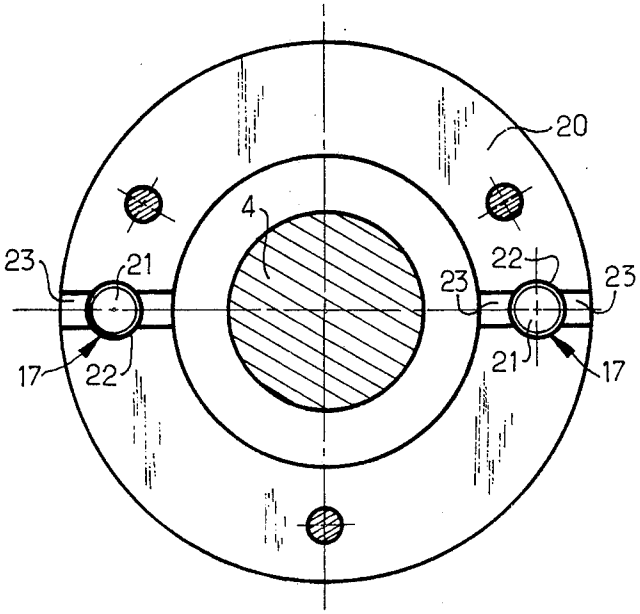
Fig: 3.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FUEL INJECTION PUMP

The present invention relates generally to fuel injection pumps and more particularly to an improved fuel injection pump for an internal combustion engine, comprising a constant-stroke, reciprocating plunger piston driven or operated by a tappet, lifter or like pusher member.

The fuel injection pumps associated with the cylinders, respectively, of an internal combustion engine and belonging to the aforesaid kind have been known for a long time. In use such pumps however exhibit a number of inconveniences such as the danger of the control toothed rack becoming blocked or jammed through seizing or sticking thereof, which toothed rack, as known, provides for the control or adjustment of the fuel flow rate delivered.

More specifically the pumps in which the present invention is concerned comprise a piston driven by a tappet and a bolster, pad or like base member slidably mounted within the body or casing of the pump and interposed between the piston and the tappet. Such an arrangement defines within the body or casing of the pump two spaces or chambers, namely a first space provided above the base member or pad towards the piston and a second space provided below the base member or pad towards the tappet. As the diameter of the tappet is larger than that of the base member or pad which also forms a cup-like seat for a piston-biasing return or drawback spring, air is compressed within both aforementioned spaces when the tappet actuates the pad hence the piston. It results therefrom that this compressed air tends to flow into the slots or slits about the toothed rack carrying along some fuel which thereby results in the risk of the toothed rack becoming seized and accordingly of impairing or adversely affecting the correct working of the pump. It is therefore desirable to avoid any air overpressure within the spaces defined within the casing or body of the pump on either side of the pad so as to prevent any danger of the toothed rack becoming blocked or jammed.

In order to obviate such an inconvenience there has already been proposed a simple solution consisting in providing one or several thoroughfare holes within the pad or base member so as to establish a constant communication between both aforesaid spaces. This would of course relieve the pressure built up within the space above the piston towards the pad, the compressed air having always the possibility to escape into the chamber located towards the tappet underneath the pad but the problem is not completely solved thereby as there will still be some air pressure present within said spaces, which would be harmful to the proper operation of the toothed rack.

The present invention obviates the aforesaid drawbacks by providing an improved fuel injection pump definitely preventing the sticking or seizing of the toothed rack caused by air overpressure within the pump casing.

More specifically the invention has for its purpose to provide a fuel injection pump for an internal combustion engine, including a constant-stroke reciprocating piston driven or actuated by a tappet as well as a pad, bolster or like base member interposed between the piston and the tappet, which pad is mounted for sliding motion within the pump casing or body, forms a cup-shaped seat for a piston-biasing return spring and comprises at least one thoroughfare hole providing communication between a first space formed above the pad towards the piston and a second space formed below the pad towards the tappet, said device being characterized in that each aforesaid hole is provided with a valve opening automatically during the upward motion of the pad through the inertia force due to the acceleration of the pad and through air compression within said first space and closing automatically during the downward motion of the pad for producing a vacuum or like underpressure through suction or drawing in within the first space.

It is thus understandable that when the pad within the pump casing is moving downwards under the action of the return spring, the air contained or trapped within the space above the pad is drawn in or sucked through and past the toothed rack thereby avoiding any seizing thereof.

According to a further characterizing feature of the invention each aforesaid valve comprises a resiliently flexible or deformable plate secured to said pad on the side of said second space formed within the pump casing between the pad and the tappet.

According to still a further characterizing feature of the invention, each aforesaid valve consists of a small disk or like plate member mounted in floating relationship within a recess or housing formed in a ring-shaped element rigidly secured to said pad.

In this other form of embodiment of the valve according to the invention it should be noted that the aforesaid recess is suitably machined to also provide for the escape of the compressed air during the upward motion of the pad.

The invention will be better understood and further objects, characterizing features, details and advantages thereof will appear more clearly as the following explanatory description proceeds with reference to the accompanying diagrammatic drawings given by way of non-limiting examples only illustrating several presently preferred forms of embodiment of the invention and wherein:

FIG. **1** is a fragmentary view in longitudinal cross-section with parts broken away, of a fuel injection pump provided with a valve according to a first form of embodiment of the invention;

FIG. **2** is a sectional view of the pad provided with a valve according to a second form of embodiment of the invention; and

FIG. **3** is a view in cross-section taken upon the line III–III in FIG. **2**.

Referring to FIG. **1**, the known component elements constituting the fuel injection pump according to the invention will be described at first.

A fuel injection pump of the kind in question essentially comprises a pump barrel or casing **1** enclosing a constant-stroke, reciprocating piston **3** and a tappet **2**. A pad or like base member **4** is interposed between the tappet **2** and the piston **3** and is mounted for sliding motion within the pump casing **1**. As clearly shown in FIG. **1**, the pad **4** forms a cup-shaped seat for a return spring **5** biasing the piston **3** and comprises a plurality of thoroughfare holes **6** providing a constant communication between a first space or chamber **7** defined above the pad **4** towards the piston **3** and a second space or chamber **8** defined below the pad **4** towards the tappet **2**. At **9** has been shown a cam rigidly connected to a shaft **10** and operating the tappet **2** by acting upon a follower or like roller **11** secured to said tappet **2**.

At **12** is shown a toothed rack operated by suitable means for turning the plunger piston **3** while allowing same to move upwards and downwards inside of the pump barrel or casing **1.** The plunger piston **3** is as known per se provided at its upper end portion with a helical ramp-like formation **13** providing for the induction of fuel in accordance with the rotary position of the plunger piston **3** controlled by the toothed rack **12.**

At **14** has been shown a breather or like snifting valve through which the space **8** is communicating with or vented to the outer atmosphere, which breather or snifting valve comprises a number of baffles **15** to cause as known per se the separation of fuel from air. Within the pump casing or barrel **1** is also provided a duct **16** for collecting or recovering the fuel leaks. It should be noted that a snifting valve or breather such as **14** may be dispensed with and when it is omitted, the entrapped air is discharged or drained off through the duct **16.**

All the elements set forth hereinabove do not call for any particular comments since they are part of the known state of the art.

According to the present invention each thoroughfare hole **6** in the pad **4** is provided with a valve **17** mounted on the side of the space or chamber **8.**

More specifically according to the form of embodiment shown in FIG. **1,** each valve **17** merely assumes the shape of a resiliently flexible plate **18** secured at **19** onto the pad **4.** The fastening may be effected by any suitable means such as rivets, screws, welding or the like. Thereby is achieved a particularly simple valving arrangement.

Referring now to FIGS. **2** and **3,** there is shown a second form of embodiment of the valve **17** according to the invention. Such a valve consists of a disk or like small plate member **21** made from a suitable material so as to be able to close the thoroughfare holes **6** of the pad **4** and fitted or accommodated in loosely floating relationship within a recess or like housing **22** machined within a ring-shaped holder or like annular support member **20** affixed to the pad **4** by any suitable means such as screws, rivets or welding. As is better apparent from FIG. **3,** the recesses **22** for the small plates or disks **21** communicate with recessed channel portions or grooves **23** formed in the annular support or ring-shaped holder **20** and enabling the air to be discharged into the space **8** when the pad **4** is moving upwards within the pump casing.

The operation and the purpose of the valves **17** will now be briefly explained when the pump is in operation.

When the tappet **2** is moving upwards under the action of the cam **9** acting upon the follower or roller **11** of the tappet, it strikes or engages the pad **4** to raise the plunger piston **3** thereby causing air to be compressed within the space **7** and accordingly the automatic opening of the valves **17.** In other words, in the case of FIG. **1,** the flexible plates **18** are disengaged or move away from the thoroughfare holes **6** and in the case of the form of embodiment of FIG. **2,** the disks **21** are resting on the bottom of the recesses **22.** The air overpressure within the space **7** is thereby avoided advantageously. It should also be pointed out that the opening of the valve is facilitated to a large extent by the force of inertia due to the acceleration of the pad **4.**

Then once the pad **4** has initiated or started its downward motion the valves **17** close automatically, i.e. as soon as the compressed air has been expelled from the space **7.** The valves **17** being thus closed and the pad effecting its downward motion by sliding within the pump casing **1,** there is provided a vacuum within the chamber **7,** i.e. there is produced a suction past the toothed rack **12** thereby advantageously preventing same to become seized by the fuel leaks. The compressed air within the space **8** is then discharged or released through the breather or snifting valve **14** and/or through the fuel-leak recovering duct **16.**

To summarize the foregoing, it may be said that when the pad **4** is moving upwards the air is not compressed or compressed very little within the space **7** and when the pad **4** is moving downwards there is produced a vacuum within the space or chamber **7** through suction or drawing into said chamber.

Thus, the problem set by the air overpressure inside a fuel injection pump of the type in question and essentially due to the relatively large diameter of the tappet **2** with respect to that of the plunger piston **3** is solved advantageously according to the present invention owing to valves provided on the holes, respectively, of the pad and assuming the shape either of flexible plates such as **18** or of disks or like elements such as **21** fitted in loosely floating relationship within an annular support member or holder **20** rigidly connected to the pad **4.**

It should be understood that the invention is not at all limited to the two forms of embodiment of the valve described and shown which have been given by way of examples only. The invention therefore comprises all the technical equivalents of the means described as well as their combinations if same are carried out according to the gist of the invention and used within the scope of the appended claims.

What is claimed is:

1. A fuel injection pump for an internal combustion engine, including a constant-stroke, reciprocating plunger piston driven according to a straight translatory motion by a tappet and rotated for adjustment by a gear consisting of an operating control toothed rack and a driven pinion coaxial with said plunger piston, and a pad interposed between said plunger piston and said tappet, which pad is slidably mounted within the pump casing while forming a cup-like seat, a return spring supported by said pad and biasing said plunger piston, said pad being formed with at least one thoroughfare hole providing communication between on the one hand a first mainly air space adjacent to said gear and defined above said pad towards said plunger piston and on the other hand a second space defined underneath said pad towards said tappet, wherein each thoroughfare hole is provided with an individual valve opening automatically during the upward motion of said pad through the force of inertia due to the acceleration of said pad and by the air compression within said first space and closing automatically during the downward motion of said pad for providing a vacuum through suction or drawing into said first space.

2. A fuel injection pump according to claim **1,** wherein each aforesaid valve comprises a resiliently flexible plate covering its associated aforesaid hole and secured on one side of said hole to said pad, on the side of said second space.

3. A fuel injection pump according to claim **1,** wherein each aforesaid valve consists of a small disk or like plate member loosely fitted in floating relationship within a recess provided in a ring-shaped element rig-

idly connected in coaxial relationship to said pad, on the side of said second space.

4. A fuel injection pump according to claim 3, wherein said ring-shaped element comprises grooves or like channels providing communication between said second space and said recesses for allowing the compressed air to be discharged or drained off during the upward motion of said pad.

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