April 7, 1964 W. FRIEDLANDER 3,127,841

FUEL INJECTION PUMPS

Filed April 6, 1960

FIG.1

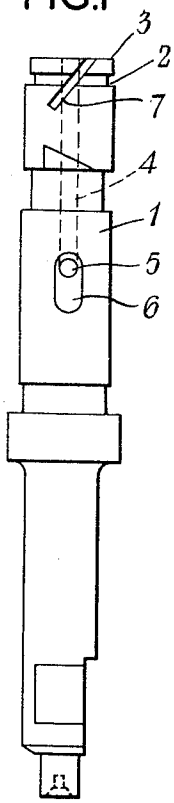


FIG.2

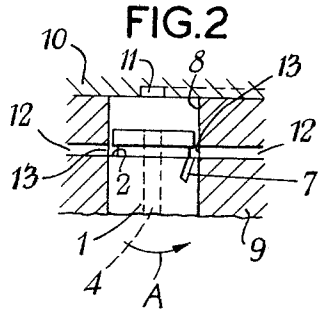
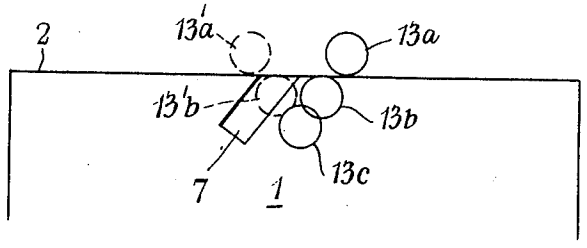


FIG.3



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FUEL INJECTION PUMPS

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This invention relates to improvements in fuel injection pumps for internal combustion engines particularly, though not exclusively, compression-ignition engines. It is concerned with improvements in such pumps of the kind (hereinafter referred to as "the kind specified") comprising a piston and cylinder pumping assembly in which the piston is driven by the engine so as to rotate and be axially displaced in the cylinder to perform the injection stroke and the cylinder has one or more fuel inlet ports opening thereinto to admit fuel to the cylinder when the piston is at the bottom of its stroke and arranged normally to be blanked off by the piston during the injection stroke of the piston.

There is a tendency for such engines to run in the reverse direction to that intended when started up or when accelerated from low engine speeds and as this results in the vehicle, to which the engine is fitted, being unexpectedly driven backwards, it can have disastrous results.

It is an object of the present invention to provide an improved fuel injection pump of the kind specified which shall prevent the engine running in the reverse direction to that intended.

According to the present invention the piston of a fuel injection pump of the kind specified is provided with means operative upon rotation of the piston in the direction opposite to that intended to maintain an inlet port in communication with the upper or operative end of the piston during the effective part of an injection stroke and prevent fuel injection taking place.

Preferably the means operative to maintain an inlet port in communication with the upper or operative end of the piston comprises a slot formed in the cylindrical wall of the piston to extend away from the upper or operative end of the piston at an angle to the generatrix of said cylindrical wall in the direction opposite to that in which the piston is intended to rotate.

One embodiment of the invention will now be described by way of example, reference being made to the accompanying drawings in which,

FIG. 1 is an elevational view of a piston according to the present invention,

FIG. 2 is a fragmentary part elevational part sectional view showing the piston of FIG. 1 at the bottom of its stroke in a cylinder, and

FIG. 3 is a view to a larger scale showing the position of an inlet port relative to the piston during an injection stroke, the inlet port being shown in full lines for the correct forward rotation of the piston and being shown in dotted lines for reverse rotation of the piston.

The piston 1 illustrated in FIG. 1 is of known type having an upper operative end 2 formed with an inoperative reduced diameter portion 3 and being formed with an axial bore 4 extending from the upper or leading end of the portion 3 to a radial bore 5 which opens into a slot 6 formed in the side wall of the piston 1 at a location to deliver fuel to an outlet port (not shown) on an injection stroke of the piston. The piston 1 is modified by the provision of a groove or slot 7 formed in the cylindrical wall of the piston 1 and extending downwardly away from the operative end 2 at an angle to the generatrix of the cylindrical wall in a direction opposite to that in which the piston 1 is intended to rotate when driven by the engine in the correct forward direction. The groove 7 may be substantially straight or helical and in this example makes an angle of 50° with the generatrix of the curved surface of the piston, has a width of 1.54 mm., a depth of 1 mm. and an effective length of 3 mm. The groove 7 may, as illustrated in FIG. 1, extend into the reduced diameter portion 3 of the piston 1 for ease of manufacture, although such an extension serves no useful purpose.

In FIG. 2 the operative end of the piston 1 is shown at the bottom of its stroke prior to an injection stroke within a fragment of a fuel injection pump which may be any suitable pump but which may, with advantage, be a pump such as is described in my co-pending application Serial No. 8,763, dated February 15, 1960, and illustrated in FIGS. 1, 3 or 4 thereof. The piston 1 is disposed for reciprocation in a cylinder 8 formed in a pump body or housing 9, the cylinder 8 being closed by a plate 10 which may, as shown, have a port 11 communicating under the control of governor means (not shown) with the low pressure side of the fuel injection pump to control the point in the injection stroke of the piston 1 at which fuel is spilled to the low pressure side and hence to control the injection period. The piston 1 is shown at the bottom of its stroke in the position it assumes just prior to commencing an injection stroke for correct forward running of the engine, the direction of rotation being indicated by the arrow A. The fuel injection pump embodying the arrangement described is intended to deliver fuel to four engine cylinders, from equi-angularly disposed outlet ports (not shown) being provided in the pump body or housing 9, each communicating with an engine cylinder and each arranged to communicate with the slot 6 during an injection stroke once per revolution of the piston 1. The piston 1 is rotated by the engine in known manner and is connected to a diametrically extending arm carrying cam profiles (not shown) which co-operate with four rollers (not shown) equi-angularly spaced about the axis of rotation of the piston 1 so as to lift the piston 1 against the influence of spring means (not shown) four times during each complete revolution and so provide four injection strokes per revolution. It will be appreciated that there is a dwell period between injection strokes during which the piston 1 continues to be rotated. Four fuel inlet passages 12 open into the cylinder 8 through equi-angularly spaced inlet ports 13, and are so arranged that fuel is admitted to the cylinder 8 when the piston is at the bottom of its stroke.

In FIG. 3 the positions of an inlet port 13 relative to the groove 7 at the commencement of an injection stroke, intermediate an injection stroke and at the end of an injection stroke are denoted by 13*a*, 13*b* and 13*c* respectively for the correct forward running of the engine. It will be seen that shortly after commencing an injection stroke the inlet port 13 is blanked-off by the piston 1 and remains blanked-off throughout the injection stroke, the groove 7 being inoperative and injection taking place in the normal manner through the axial bore 4, radial bore 5, slot 6 and the appropriate outlet port.

If, however, the engine inadvertently reverses its direction of drive, the direction of rotation of the piston 1 will be reversed and during the dwell period referred to above will be rotated through an angle less than 90° before commencing its injection stroke so that the position of an inlet port relative to the groove 7 at the instant of commencement of an injection stroke will be that denoted in dotted lines and by the reference 13'*a*. At an intermediate point in the injection stroke the relative position of the inlet port is denoted by 13'*b*, the port 13 remaining

in communication with the cylinder 8 through the groove 7. It will be seen therefore that during the injection stroke, with the engine running in the reverse direction an inlet port 13 remains in communication with the upper or operative end 2 of the piston 1 by way of the groove 7 so that no injection can take place. It is possible that at the end of the injection stroke of the piston 1 the inlet port 13 will be blanked-off in the arrangement described but this is not material as the upper end of the injection stroke of the piston 1 is not usually effective to provide injection as the pump is commonly arranged to spill before the end of the injection stroke is reached. It will be appreciated that, if desired, the groove 7 may be suitably shaped and dimensioned so as to maintain the inlet port 13 in communication with the upper or operative end 2 of the piston 1 throughout an injection stroke of the piston when the engine is running in the reverse direction, although, as explained above, it is only necessary for this condition to exist during the effective part of the injection stroke. As no injection takes place under the conditions described, it will be seen that the engine cannot run in the direction opposite to that intended.

It will be appreciated that the arrangement described above may be modified in a number of ways without departing from the scope of the invention. Thus, for example, instead of the cylinder 8 having a number of inlet ports 13 corresponding to the number of injection strokes per revolution of the piston 1, a single port 13 may be provided and the piston 1 provided with a number of grooves 7 corresponding in number to the number of injection strokes per revolution, or there may be provided a number of grooves 7 and a number of inlet ports 13. Thus it is possible to achieve the desired result for a pump feeding four engine cylinders by providing two inlet ports 13 and two grooves 7, either the inlet ports 13 or the grooves 7 occurring at 180° intervals and the grooves 7 or the inlet ports 13 being spaced 90° apart. Thus the product of the number of fuel inlet ports 13 and the number of grooves 7 should correspond to the number of engine cylinders to be served by the pump.

What I claim is:

1. In a fuel injection pump, in combination, a cylinder; an injection piston mounted in said cylinder for reciprocation through injection and retraction strokes thereof; said injection piston having an axial fuel injection passage therethrough having a discharge opening through the injection end thereof and having an injection discharge port therefrom through a side wall of said piston; said cylinder providing an inlet port opening thereinto for supply of fuel to the injection end of said cylinder for injection therefrom by and through said piston on injection strokes of the latter; said piston being also mounted for rotation in said cylinder and being adapted to be rotated in one direction during normal operation thereof; said cylinder providing a discharge port therefrom at the injection end thereof; said piston being provided with an angularly positioned slot therein disposed longitudinally thereof at an angle to the axis of said piston in a direction opposite the direction of rotation of said piston in normal operation thereof; and said piston upon rotation thereof in the direction opposite said direction of normal rotation positioning said angularly disposed slot in open communication with said inlet port during an injection stroke of said piston for discharge of fuel from said cylinder through said inlet port.

2. In a fuel injection pump, in combination, a cylinder; an injection piston reciprocally and rotatably mounted in said cylinder; said piston having an axial fuel injection passage therethrough opening through the injection end of said piston and having an injection discharge port from said axial passage through the side wall of said piston; said cylinder having an inlet port opening through the side wall thereof for supply of fuel into said cylinder for injection by said piston through said axial injection passage on injection strokes of said piston; said piston on injection strokes thereof blocking off said inlet port; said piston being adapted for rotation in said cylinder in one direction during normal operation thereof; said cylinder having a discharge outlet therefrom at the injection end thereof for discharge of fuel therethrough from said cylinder; said piston having a slot formed in the side wall thereof extending from the injection end of said piston inwardly therealong at an angle to the generatrix of said piston wall in the direction opposite the direction of rotation of said piston in normal operation thereof; and said piston when rotated in the direction opposite the direction of normal rotation thereof positioning said slot to open said inlet port to said cylinder on injection strokes of said piston for discharge of fuel from said cylinder through said inlet port.

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