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FUEL INJECTION PUMP FOR INTERNAL COMBUSTION ENGINES

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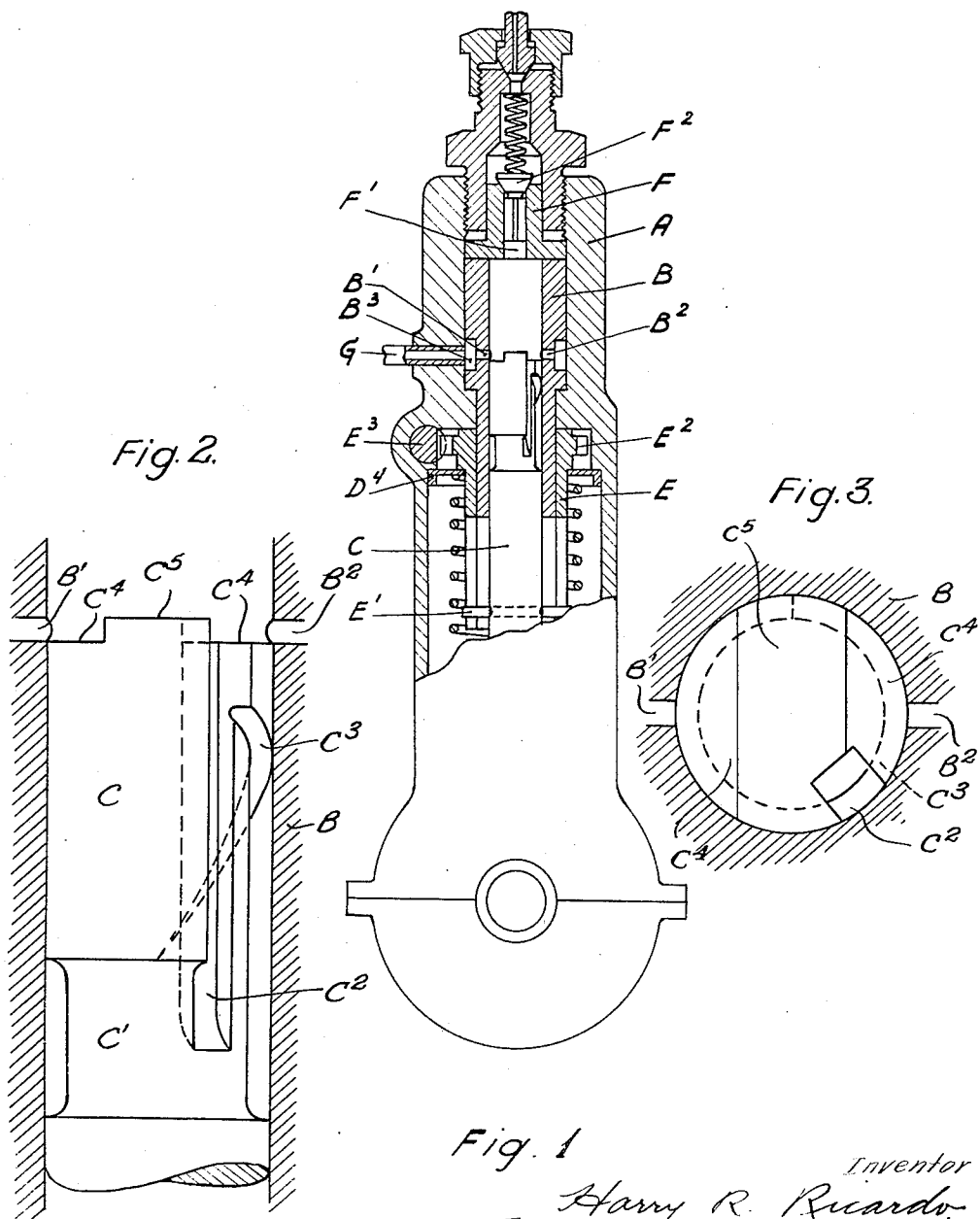


Fig. 1

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FUEL INJECTION PUMP FOR INTERNAL COMBUSTION ENGINES

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5 Claims. (Cl. 123—139)

This invention relates to fuel injection pumps for internal combustion engines and of the kind comprising a pump plunger which is reciprocated in a cylinder furnished with a suction port controlled by the plunger so that the injection period commences when the end of the plunger, during its delivery stroke, moves over the suction port.

In a fuel injection pump according to the present invention at least one flat is cut or formed at the end of the pump plunger in a plane normal to the axis thereof so as to form at the end of the plunger at least one extension which projects beyond the said plane and is bounded in part by an arc or arcs constituting part of the plunger circumference.

Thus, when the relative rotational positions of the plunger and the cylinder are such that the extension at the end of the plunger moves over the suction port during reciprocation of the plunger, the latter will commence to apply pressure to the fuel charge earlier in the delivery stroke thereby advancing the timing of the commencement of injection, say, during starting of the engine when it may be desirable appreciably to increase the charge injected. By turning the plunger or the cylinder about its longitudinal axis, however, so that the suction port is not closed until the edge of the plunger in the plane of the flat has passed over the suction port during the delivery stroke, the commencement of injection will be retarded, say to suit normal working.

The invention is particularly, though not exclusively, applicable to pumps of the kind in which the quantity of fuel injected into the engine cylinder is determined by adjusting the point in the plunger stroke, at the end of the fuel delivery, at which the working chamber of the pump is brought into communication with a relief port. Thus, for example, the pump plunger may be furnished with a control edge inclined to the axis of the cylinder and cooperating with a relief port in the cylinder wall, means being provided for turning the plunger about its longitudinal axis so as to vary the point in the delivery stroke at which the control edge uncovers the relief port and thus determines the end of the injection period. The arrangement according to the invention is conveniently such that with the plunger in a position of rotation suitable for starting purposes, that is to say so that the inclined control edge does not uncover the relief port until late in the delivery stroke of the plunger, the extension at the end of the plunger

will, as the plunger reciprocates, move over the suction port so that this will be closed earlier in the delivery stroke, the commencement of the injection period being thus advanced accordingly. After the starting period and when the plunger has been turned so as to cause the inclined control edge to uncover the relief port earlier in the delivery stroke of the plunger, say, for normal running conditions, the extension at the end of the plunger will no longer move over the suction port which will therefore be controlled by the edge at the end of the plunger in the plane of the flat, the commencement of each injection period being thus retarded to suit normal load conditions.

It will be appreciated that the extension at the end of the plunger rises preferably sharply from the plane of the flat or flats and is bounded in part by an arc or arcs which constitute parts only of the plunger circumference so that the said projection will cooperate with the suction port only over a part of the range of rotary adjustment of the plunger or the cylinder. Adjustment of the point in the plunger stroke at which the inclined control edge uncovers the relief port to determine the end of the injection period can thus be effected over a wide range without thereby simultaneously altering the timing of the commencement of the injection period.

The invention may be carried out in various ways but one construction according to the invention is shown by way of example in the accompanying drawing, in which

Figure 1 is a side elevation, partly in section, of the complete fuel pump,

Figure 2 is an enlarged view of the upper end of the plunger of the pump shown in Figure 1, and

Figure 3 is a plan of the plunger on the same scale as Figure 2.

In the construction illustrated the pump comprises a casing A containing a cylinder B within which reciprocates a plunger C. Reciprocating movement is imparted to the plunger for example in known manner by a cam.

The lower end of the cylinder B is freely surrounded by a sleeve E which is held from vertical movement by a thrust member D⁴ and extends below the lower end of the cylinder B where it is provided with two longitudinal slots in which slide the ends of a transverse pin E¹ carried by the plunger. The upper end of the sleeve E is formed as a gear wheel E² which is engaged by a longitudinally movable manually operated rack E³ whereby the sleeve E can be

rocked about its axis and hence through the pin E¹ cause rocking movement of the plunger.

The upper end of the cylinder B is closed by a member F in which is formed a delivery passage F¹ controlled by a spring-pressed non-return valve F².

Formed in the cylinder B are suction and relief ports B¹ and B² respectively arranged approximately diametrically opposite to each other, the relief port B² communicating through an annular chamber B³ with a fuel supply pipe G through which fuel flows to the suction port. Alternatively, the relief port B² may communicate with a separate relief passage.

The plunger C is provided with a part C¹ of reduced diameter constituting a recess which is in constant communication through a slot or groove C² with the pump pressure chamber and has a helical upper edge C³ which constitutes a control edge cooperating with the relief port B² to control communication between this port and the slot or groove C².

Cut or formed at the upper end of the plunger C are two flats C⁴ lying in a common plane normal to the plunger axis so as to form between them an extension C⁵ bounded in part by arcs constituting parts of the plunger circumference.

The stroke of the plunger is such that at the beginning of each delivery stroke the suction and relief ports B¹, B² are uncovered by the end of the plunger while during the later parts of each delivery stroke the relief port B² is uncovered by the control edge C³ and comes into communication with the recess C¹ so that only an intermediate part of each plunger stroke is operative to deliver fuel through the delivery passage F¹.

The plunger is shown in the rotational position for normal running in which, it will be seen, the operative part of each delivery stroke will not begin until the flats C⁴ pass the ports B¹, B². For starting purposes, however, the plunger can be rocked by longitudinal movement of the rack E³ so as to bring the extension C⁵ in or approximately in alignment with the ports B¹, B², when the operative part of each delivery stroke will begin as soon as the ports B¹, B² are covered by the extension C⁵.

It will therefore be seen that with the plunger in its starting position, not only will injection begin earlier in each delivery stroke but a greater quantity of fuel will be delivered than during normal running. As normal operation of the engine is attained, the plunger is turned about its longitudinal axis, say, by a governor acting on the rack E³, so that the point in the delivery stroke of the plunger at which the control edge uncovers the relief port is advanced. After a predetermined rotation of the plunger, as determined by the length of the arcs bounding the ends of the extension C⁵, this extension will no longer cooperate with the suction and delivery ports which will therefore not be covered during the delivery stroke of the plunger until the edge in the plane of the flats C⁴ has passed over these ports. The beginning of the injection period will now be retarded to suit normal loads and further rotation of the plunger to cause the injection period to terminate earlier in the delivery stroke of the plunger can be effected without thereby altering the timing of the beginning of injection.

In the drawing the plunger is shown at an intermediate point in its stroke and at the beginning of the delivery stroke the upper end of the extension C⁵ lies appreciably below the level of the ports B¹, B².

It will be appreciated that the invention provides for adjustment of the timing of the beginning of the injection period and that it may be applied in conjunction with any suitable means of known type for regulating the termination of each injection period. Thus, the invention is not only applicable to pumps of the type above referred to in which the end of the injection period is determined by an inclined control edge, such as C³, on the plunger, but also to arrangements in which an inclined control edge or port on a rotary cylinder or sleeve within which the plunger can be turned can itself be rotated about its longitudinal axis relatively to the plunger.

Further, the rocking of the plunger or other control to vary the point of termination of each injection period may be effected either manually or automatically, for example by a governor, and, in this latter case, the arrangement may be such that at starting speeds the governor maintains the plunger in its starting position but moves it to its normal running position as normal running conditions are attained.

I claim as my invention:

1. A fuel injection pump for internal combustion engines comprising a cylinder having a suction port in its cylindrical wall, and a pump plunger adapted to reciprocate within said cylinder and to control the suction port, so that the injection period begins when the end of the plunger during its delivery stroke moves over the suction port, said plunger being rotatable about its longitudinal axis within said cylinder and being provided at its end with an end face in a plane normal to the axis of the plunger, from which end face projects an extension bounded laterally in part by at least one arcuate surface constituting part of the cylindrical surface of the plunger, said arcuate surface terminating laterally in at least one edge which is parallel to the longitudinal axis of the plunger.

2. A fuel injection pump for internal combustion engines comprising a cylinder having a suction port in its cylindrical wall, and a pump plunger adapted to reciprocate within said cylinder and to control the suction port, so that the injection period begins when the end of the plunger during its delivery stroke moves over the suction port, said plunger being rotatable about its longitudinal axis within said cylinder and being provided at its end with an extension formed by forming in the end of the plunger on opposite sides of its longitudinal axis two flat surfaces in a plane normal to the axis of the plunger, said flat surfaces leaving between them said extension bounded on two sides by arcuate surfaces which constitute opposite parts of the cylindrical surface of the plunger and which terminate laterally in edges which are parallel to the longitudinal axis of the plunger.

3. A fuel injection pump for internal combustion engines, comprising a cylinder having at least one port in its cylindrical wall, and a pump plunger reciprocating therein having a control edge inclined to the length thereof and an end face normal to the longitudinal axis of the plunger, from which end face projects an extension bounded laterally in part by at least one arcuate surface which constitutes a part of the cylindrical surface of the plunger, said arcuate surface terminating laterally in at least one edge parallel to the longitudinal axis of the plunger, the plunger being rotatable about its longitudinal axis so as to bring either the extended or the

non-extended part of the plunger end into such a position as to cause closing of the port in the cylinder wall during the delivery stroke and to vary the point in the delivery stroke at which the inclined control edge uncovers the said port.

5 4. A fuel injection pump for internal combustion engines, comprising a cylinder having at least one port in its cylindrical wall, and a pump plunger reciprocating therein having a control
10 edge inclined to the length thereof and an end face normal to the longitudinal axis of the plunger, from which end face projects an extension bounded laterally in part by at least one
15 arcuate surface which constitutes a part of the cylindrical surface of the plunger, said arcuate surface terminating laterally in at least one edge parallel to the longitudinal axis of the plunger, the plunger being rotatable about its longitudinal
20 axis so as to bring either the extended or the non-extended part of the plunger into such position as to cause closing of the port in the cylinder wall during the delivery stroke and to vary the point in the delivery stroke at which the control edge uncovers the said port, the disposition
25 of the projection in relation to the control edge

being such that the non-extended part of the plunger end closes the port during the delivery stroke when the plunger is in the rotational positions for earlier uncovering of the port by the control edge and the extension covers the port when the plunger is in a rotational position for substantially the latest uncovering of the port by the control edge. 5

5. A fuel injection pump for internal combustion engines, comprising a cylinder having a
10 suction port in its cylindrical wall, and a generally cylindrical pump plunger, adapted to reciprocate within said cylinder and to control the suction port, so that the injection period begins when the end of the plunger during its delivery
15 stroke moves over the suction port, said plunger being rotatable about its longitudinal axis within said cylinder and being provided at its end with an end face in a plane normal to the axis of the
20 plunger, from which end face projects an extension presenting a partial-cylindrical surface forming a continuation of the plunger periphery, said surface being bounded at least at one side by a line parallel to the axis of the plunger. 20

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