July 4, 1933. R. W. VIGERS ET AL 1,917,169

LIQUID FUEL INJECTION PUMP FOR INTERNAL COMBUSTION ENGINES

Filed Aug. 13, 1931

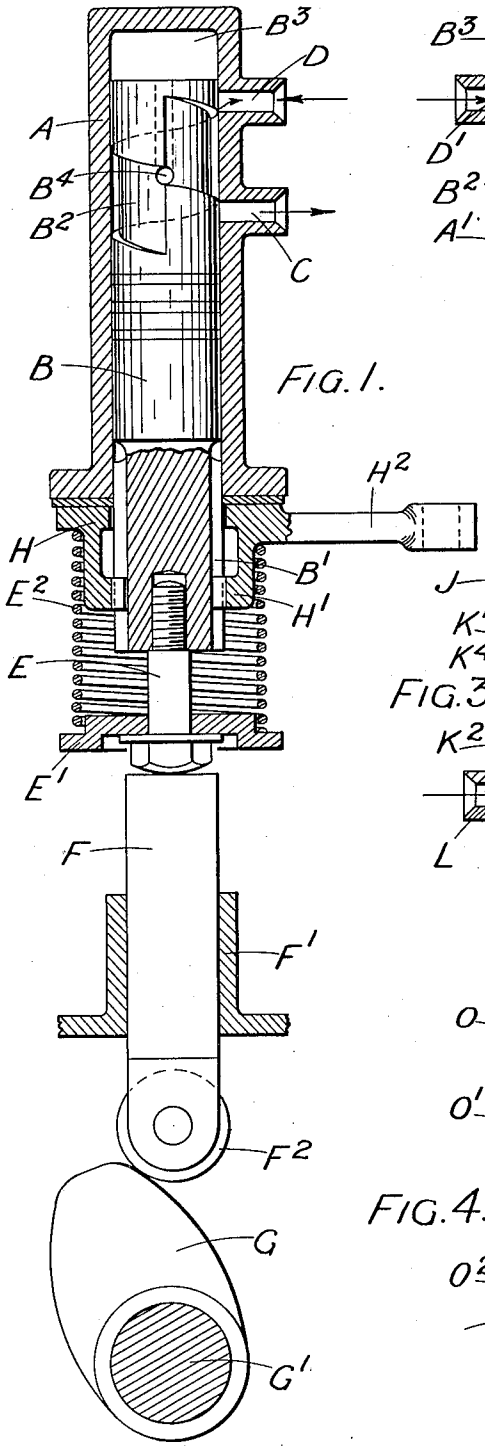


FIG. 1.

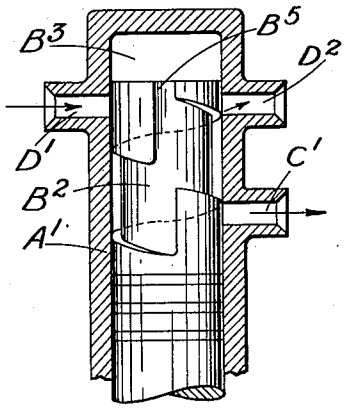


FIG. 2.

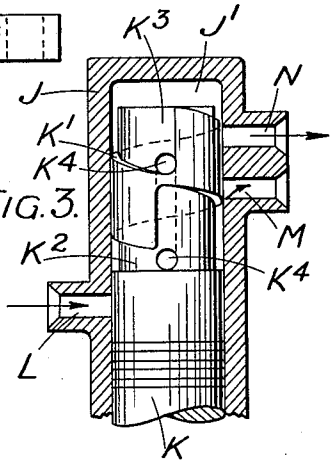


FIG. 3.

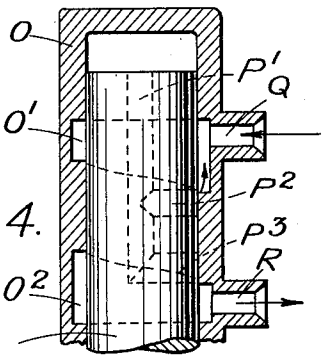


FIG. 4.

INVENTORS.
R.W. VIGERS.
Per. E.E. CHATTERTON.
Blair & Kilcoyne Attnys.

Patented July 4, 1933 1,917,169

UNITED STATES PATENT OFFICE

RONALD WHITEHAIR VIGERS AND ERNEST EDWARD CHATTERTON, OF LONDON, ENGLAND, ASSIGNORS TO D. NAPIER & SON LIMITED, OF LONDON, ENGLAND, A COMPANY OF GREAT BRITAIN

LIQUID FUEL INJECTION PUMP FOR INTERNAL COMBUSTION ENGINES

Application filed August 13, 1931, Serial No. 556,928, and in Great Britain September 26, 1930.

This invention relates to liquid fuel injection pumps for internal combustion engines and has for its object to provide an improved fuel injection pump of the kind having one or more inlet or relief ports which are so controlled by the pump plunger or by a separate valve as to be opened during both the earlier and later portions of each plunger delivery stroke to render these portions of the stroke inoperative so that fuel is only forced through the delivery passage during an intermediate operative part of each delivery stroke.

In a liquid fuel injection pump of the above kind according to the present invention, means are provided for positively closing the delivery passage at the moment when or immediately after the relief or inlet port is opened to terminate the operative part of the delivery stroke. The invention is particularly applicable to fuel injection pumps in which the pump piston acts both as a plunger and as the valve controlling the inlet or relief port or ports in the cylinder wall, and in this case the delivery port is preferably also arranged in the cylinder wall and the piston so formed as to close the delivery port positively as or immediately after it opens the relief port to terminate the effective portion of the delivery stroke.

In liquid fuel injection pumps wherein the pump plunger acts also as a valve, it is usual to provide a relief groove in the cylinder or piston having a helical or like inclined edge so that by varying the relative rotational positions of the cylinder and piston the moment in the plunger delivery stroke at which the relief port is brought into communication with the pump pressure chamber can be varied so as to vary the quantity of fuel delivered. When the present invention is applied to such a construction, a delivery groove having a corresponding helical or like inclined edge is conveniently provided in the cylinder or piston so that when the moment of opening the relief port is varied, e. g. by rotating the piston relatively to the cylinder, the moment of closing of the delivery passage is correspondingly varied whereby the closing of the delivery port at the moment of or immediately after the opening of the relief port to terminate the effective portion of the delivery stroke is ensured whatever the relative rotational settings of the cylinder and piston.

The invention may be carried into practice in various ways but three alternative constructions according to this invention together with a modification of one of such constructions are illustrated by way of example in the accompanying drawing, in which

Figure 1 is a sectional side elevation of one construction,

Figure 2 is a sectional side elevation showing a modified form of piston and cylinder which may be employed in the construction shown in Figure 1,

Figure 3 is a sectional side elevation of the operative part of the cylinder and piston of an alternative form of fuel pump according to this invention, and

Figure 4 is a similar view to Figure 3 of the operative part of the piston and cylinder of a still further construction of fuel pump according to this invention.

In the construction shown in Figure 1 the fuel pump comprises a cylinder A containing a piston B and having a delivery port C and a combined inlet and relief port D in its circumferential wall. Mounted in a screwthreaded bore in the lower end of the piston B is a bolt E on which acts the upper end of a tappet F mounted in a guide F^1 and carrying at its lower end a roller F^2 which engages a cam G on a camshaft G^1. A collar E^1 surrounds the shank of the bolt and is acted upon by the lower end of a compression spring E^2 which serves to maintain the bolt E always in contact with the tappet F and the roller F^2 in contact with the surface of the cam G. The upper end of the spring E^2 bears upon an adjusting member H surrounding the lower end of the plunger B and having a part H^1 which is internally splined to engage corresponding external splines B^1 on the plunger so that the plunger can reciprocate independently of the member H but by rocking the member H by means of a lever H^2 thereon the rotational position

of the plunger B relatively to the cylinder A can be varied.

Formed in the circumferential wall of the plunger B adjacent to its upper end is a helical relief groove B^2 which communicates with the pressure chamber B^3 of the pump through a passage B^4 in the piston.

The arrangement is such that the plunger on the suction stroke draws in fuel through the combined inlet and relief port D. During the initial part of the delivery stroke of the plunger the port D is uncovered by the piston, so that during this portion of the delivery stroke fuel is returned to the inlet passage through the combined inlet and relief port D. After the plunger has moved a certain distance on its delivery stroke it covers the port D so that flow of fuel through this port is stopped and fuel is forced through the passage B^4 and groove B^2 and thence through the delivery port C which during this period communicates with the groove B^2. Such delivery continues until the upper edge of the groove B^2 uncovers the port D and the arrangement is such that as or immediately after the port D is uncovered by the upper edge of the groove B^2 the lower edge of this groove closes the delivery port C so that at the moment when or immediately after communication is reestablished between the pressure chamber of the pump and the relief port, communication between this pressure chamber and the delivery port is cut off.

It will be seen that by rocking the plunger B by means of the lever H^2 the length of the effective portion of the delivery stroke during which the port D is closed, and hence the quantity of fuel injected, can be varied but that at all rotational settings of the plunger the delivery port C will be closed positively by the lower edge of the groove B^2 at the moment when or immediately after the relief port D is reopened to terminate the effective portion of the delivery stroke.

In the construction shown in Figure 2 the arrangement is generally similar to that shown in Figure 1 except that the cylinder A^1 is provided with a port D^1 which acts solely as an inlet port and has a separate relief port D^2 in addition to the delivery port C^1, the arrangement being such that some of the fuel drawn in through the inlet port D^1 on the suction stroke of the pump is forced out again during the initial and final stages of the delivery stroke through the relief port D^2. In this construction also, instead of the helical recess B^2 in the piston communicating with the pump pressure chamber B^3 through a passage in the piston, it communicates with the pressure chamber through a slot B^5 in the circumferential wall of this piston.

In the alternative construction illustrated in Figure 3, the pump comprises a cylinder J within which reciprocates a piston K. The cylinder is provided with a combined inlet and relief port L, a further relief port M and a delivery port N, while the piston is provided with a helical upper edge K^1 and also with a circumferential groove K^2 having a helical upper edge. In order to reduce the quantity of fuel in the pressure chamber J^1 the plunger is provided with a portion K^3 of reduced diameter which extends above the upper helical edge K^1 as shown. The groove K^2 communicates with the pressure chamber of the pump through a passage K^4 in the plunger.

In this construction fuel is drawn in from the ports L and M through the groove K^2 and passage K^4 during the suction stroke and during the initial part of the delivery stroke is forced out through the combined inlet and relief port L. When the lower edge of the groove K^2 covers the port L fuel is delivered from the pressure chamber of the pump through the delivery passage N and this delivery continues until the upper helical edge of the groove K^2 uncovers the relief port M. As or immediately after the relief port M is thus uncovered the helical edge K^1 covers the delivery port N so that this port is positively closed at or immediately after the moment when the relief port M is opened to terminate delivery.

In this construction also, by rotating the plunger it will be seen that the length of the effective portion of the delivery stroke of the plunger can be varied but that whatever the rotational position of the plunger the delivery port N will always be closed at or immediately after the moment when the relief port M is opened to terminate the effective portion of the delivery stroke.

In the construction shown in Figure 4 the pump comprises a cylinder O within which reciprocates a piston P. The cylinder is provided with two internal circumferential grooves O^1, O^2, the groove O^1 having a lower helical edge while the groove O^2 has an upper helical edge. The groove O^1 communicates with a combined inlet and relief passage Q while the groove O^2 communicates with a delivery passage R.

Formed in the piston P is a vertical passage P^1 from which lead two radial passages P^2, P^3 adapted to communicate respectively with the grooves O^1, O^2 in the cylinder during the desired portions of the piston stroke.

With this construction fuel is drawn in through the passage Q during the suction stroke, the face of the piston lying below the upper edge of the groove at the end of such suction stroke so that during the initial part of the delivery stroke fuel is forced from the pressure chamber of the pump back into the inlet passage Q. As soon as the upper face of the piston P passes the upper edge of

the groove O^1 fuel begins to be delivered through the passages P^1 and P^3 into the groove O^2 and thence through the delivery passage R, and this delivery continues until the passage P^2 comes into communication with the groove O^1. At or immediately after the moment when the passage P^2 comes into communication with the groove O^1, the passage P^2 passes the upper edge of the groove O^2 so that the pressure chamber of the pump is substantially simultaneously cut off from communication with the delivery passage R and brought into communication with the combined relief and inlet passage Q to terminate the effective portion of the plunger delivery stroke.

In this construction also by rotating the plunger P the length of the effective portion of its delivery stroke can be varied but whatever its rotational position the passage P^3 will always be positively closed by the upper edge of the groove O^2 approximately at the moment when the passage P^2 comes into communication with the groove O^1 to terminate the fuel delivery period.

It is to be understood that the constructions illustrated are given by way of example only and that the means for positively closing the delivery passage at or immediately after the moment when the relief port is opened to terminate the effective part of the delivery stroke may be separate from the pump plunger and other details of construction may be varied without departing from this invention. Further the invention may be applied to fuel injection pumps in which a separate valve controlling inlet or relief ports is operated in timed relation to the piston to render inoperative the earlier and later portions of each plunger delivery stroke.

What we claim as our invention and desire to secure by Letters Patent is:—

1. A liquid fuel injection pump for internal combustion engines, including in combination a cylinder having a delivery passage, a relief passage and at least one relief port, a plunger adapted to reciprocate within the cylinder and act as a valve to open a relief port during the later part of the suction stroke and beginning of each delivery stroke and having on the one hand a relief groove therein which uncovers a relief port during the later part of each delivery stroke so that fuel is only delivered through the delivery passage during an intermediate operative part of each delivery stroke, and on the other hand a delivery groove which communicates with the delivery passage during at least such intermediate part of the delivery stroke but has an edge which covers the delivery passage as the relief groove comes into communication with the relief port, the edge on the relief groove which uncovers the relief port and the edge on the delivery groove which covers the delivery port at the end of the fuel delivery period being formed correspondingly helical, and means for causing relative rotation between the pump plunger and the cylinder whereby the quantity of fuel delivered on each delivery stroke can be varied while maintaining synchronism between the opening of the relief port and the closing of the delivery passage at the end of the delivery period.

2. A liquid fuel injection pump for internal combustion engines including in combination a cylinder having a fuel delivery passage and at least one relief port, a plunger adapted to reciprocate within the cylinder, means acting as a valve to open a relief port and maintain it open during the end of the suction stroke and the beginning and end of each delivery stroke, whereby fuel is only delivered through the delivery passage during an intermediate operative part of each delivery stroke, and means for positively closing the fuel delivery passage against pressure within the pump pressure chamber as the relief passage is opened to terminate the delivery period.

3. A liquid fuel injection pump for internal combustion engines, including in combination a cylinder having a fuel delivery passage and at least one relief port, a plunger adapted to reciprocate within the cylinder and act as a valve to open a relief port and maintain it open during the end of the suction stroke and the beginning and end of each delivery stroke, whereby fuel is only delivered through the delivery passage during an intermediate operative part of each delivery stroke, and means for positively closing the fuel delivery passage against pressure within the pump pressure chamber as the relief passage is opened to terminate the delivery period.

4. A liquid fuel injection pump for internal combustion engines, including in combination a cylinder having a fuel delivery passage and at least one relief port, a plunger adapted to reciprocate within the cylinder and having a part acting as a valve which not only maintains open a relief port during the later part of each suction stroke and the beginning and end of each delivery stroke, whereby fuel is only delivered through the delivery passage during an intermediate operative part of each delivery stroke, but also as a valve for positively closing the fuel delivery passage as the relief port is opened to terminate the delivery period.

5. A liquid fuel injection pump for internal combustion engines including in combination a cylinder having a fuel delivery passage and at least one relief port, a plunger adapted to reciprocate within the cylinder, means acting as a valve and having controlling edges thereon which maintain open a relief port during the earlier and later parts of each delivery stroke, the controlling edge

on the valve which opens the relief port during the later part of each delivery stroke being helically inclined to the direction of movement of the reciprocating part, a further correspondingly helical controlling edge on the valve which closes the delivery passage as the relief port is opened to terminate the effective part of the delivery stroke, and means for rotating the valve so as to vary the quantity of fuel injected by the pump on each delivery stroke while maintaining synchronism between the opening of the relief port and the closing of the delivery port at the end of the delivery period.

In testimony whereof we have signed our names to this specification.

RONALD WHITEHAIR VIGERS.
ERNEST EDWARD CHATTERTON.