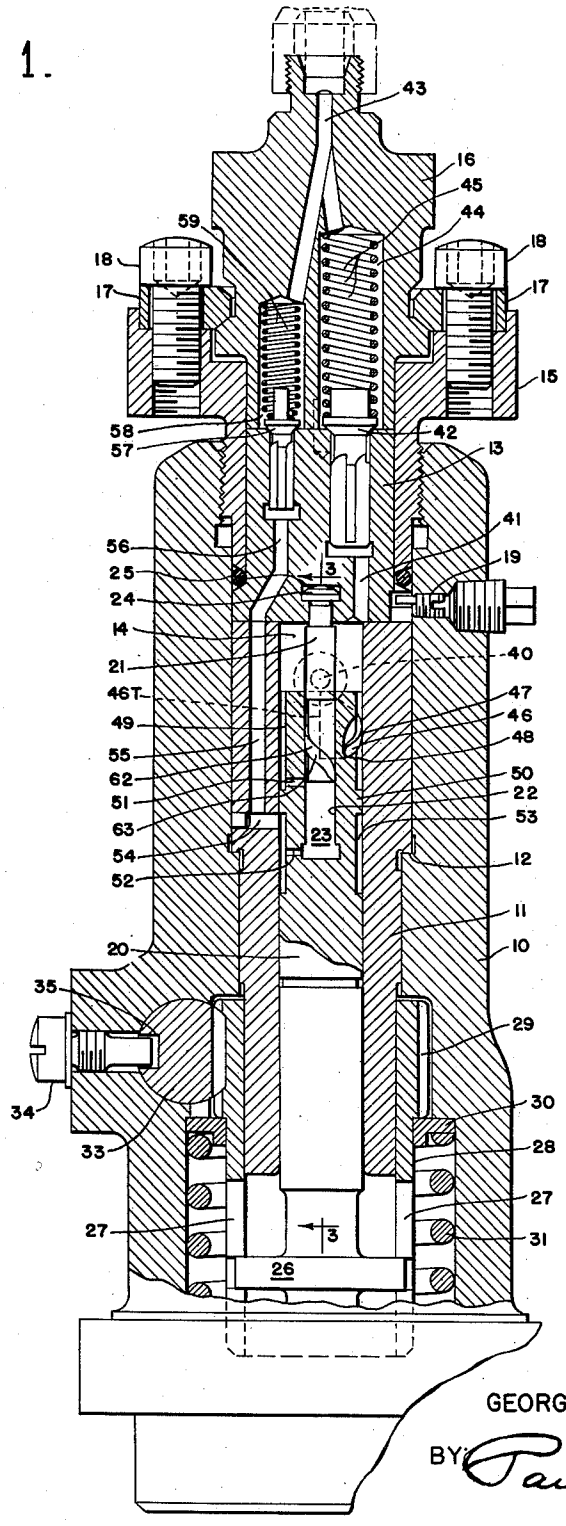
April 27, 1954 G. A. SCHAUER, JR 2,676,544

FUEL INJECTION PUMP FOR DUAL FUEL ENGINES

Filed Aug. 15, 1950 2 Sheets-Sheet 1

FIG. 1.



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FUEL INJECTION PUMP FOR DUAL FUEL ENGINES

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FIG. 2.

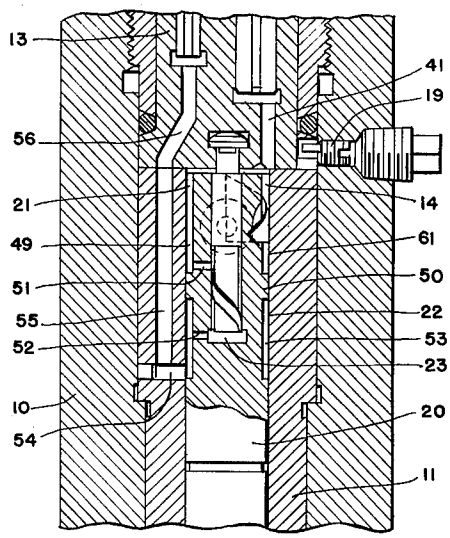


FIG. 3.

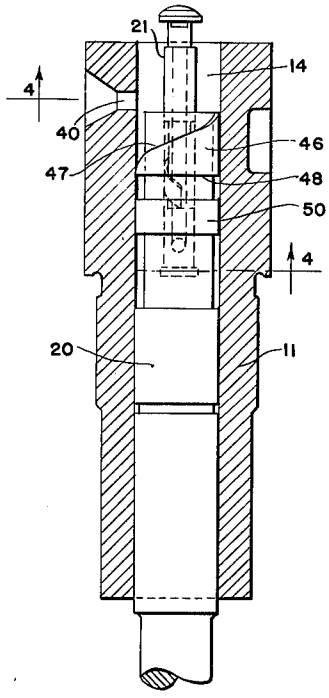


FIG. 5.

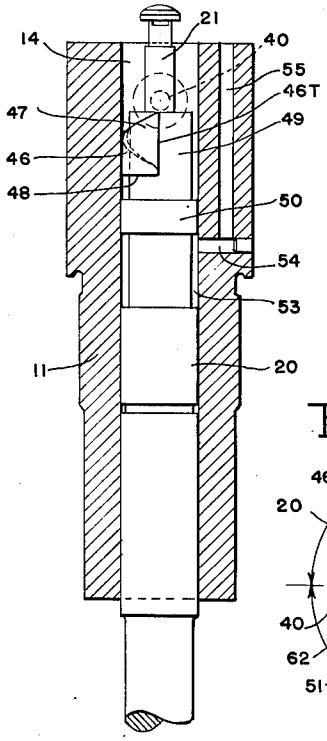


FIG. 4.

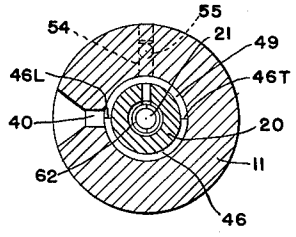
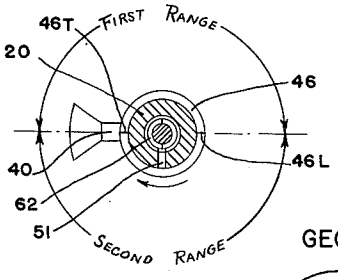


FIG. 6.



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2,676,544

FUEL INJECTION PUMP FOR DUAL FUEL ENGINES

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Application August 15, 1950, Serial No. 179,481

17 Claims. (Cl. 103—41)

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This invention relates to improvements in fuel injection pumps for internal combustion engines, and has reference more particularly to an injection pump of novel character, suitable for use with engines adapted for operation selectively on liquid fuel alone, or on liquid and gaseous fuels in desired or determined proportions.

For the purpose of present exemplary disclosure of the invention, the fuel pump as herein illustrated and described represents one embodiment within the principles of the invention, adapted for use with so-called convertible dual fuel engines operating either on gaseous fuel with pilot injection of liquid fuel for ignition of the gaseous fuel, or on liquid fuel alone. As will appear more fully hereinafter, the pump selected for illustration includes a cylinder assembly providing a main pump chamber, and telescopically related pistons therein forming an auxiliary pump chamber which is supplied with liquid fuel from the main chamber and discharges to the injection delivery passage leading from the main chamber. One of the pistons is engine operated and is angularly adjustable preferably under engine governor control, for determining through control means on the piston, both timing and quantity of fuel delivery from the main chamber. The other piston is fixed in the cylinder and is provided with control means effective relative to an inlet port in the first piston, to determine constant quantity fuel delivery from the auxiliary chamber consequent upon the pumping stroke of the first piston and at a time in such stroke dependent upon angular adjustment of the first piston. Moreover, the control means of both pistons are so designed and related in the assembly, that throughout a first range of angular adjustment of the first piston, fuel is delivered from the auxiliary chamber only, and at a time progressively later in the pumping stroke of the first piston as the latter piston is angularly adjusted toward the end of the first range of such adjustment. Upon angular displacement of the first piston beyond the first range, as to and through a second range of adjustment, fuel delivery occurs only from the main chamber, with injection beginning earlier in the pump stroke of the piston and with increasing fuel quantity, as the piston is angularly adjusted toward the end of its second range.

Objectively stated, one of the principal purposes of the present invention is to provide a fuel pump of the character above indicated, which affords pilot injection of fuel in constant quantity suitable as an ignition charge in an engine operating on a gaseous fuel, and which embodies pilot injection timing control provisions for retarding pilot injection proportionately to increasing engine loading whereby to reduce or avoid detonation, and conversely, for advancing pilot injection proportionately to decreasing engine loading whereby to improve the gaseous fuel consumption factor of the engine at relatively light loads.

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Another object is to provide a fuel pump of the character herein above described, suitable for use with a convertible dual fuel engine and operable to provide a constant quantity, variably timed pilot injection of liquid fuel for igniting the gaseous fuel employed in gas operation of the engine, and operable further, to provide liquid fuel injection without the pilot injection, upon conversion of the engine to liquid fuel or diesel operation.

A further object is to provide a liquid fuel pump of the character indicated, providing telescopically related fixed and movable pistons each having inlet port control elements, wherein regulation of pilot fuel injection and main fuel injection and the limitation of pump operation to pilot injection or to main injection, are obtained consequent to angular adjustments of the movable piston.

These and other objects and advantages of the present invention will appear readily from the following detailed description of the embodiment selected for illustration and shown in the accompanying drawing, wherein:

Fig. 1 is a longitudinal sectional elevation through a fuel pump assembly illustrating one embodiment of the present invention, the view showing the movable plunger at the end of its suction stroke.

Fig. 2 is a fragmentary sectional elevation according to that of Fig. 1, showing the movable plunger at the end of its discharge stroke.

Fig. 3 is a fragmentary sectional elevation showing certain details of the pump assembly and particularly disclosing the control means associated with the movable plunger, the view being taken along line 3—3 of Fig. 1.

Fig. 4 is a transverse sectional view taken at line 4—4 of Fig. 3.

Fig. 5 is a view similar to that of Fig. 3 but with the section taken at 90° to the section of Fig. 3 in order to show further details of the primary piston control means.

Fig. 6 is a diagrammatic view, showing the initial relations of the control elements and inlet ports.

Referring in particular to Figs. 1 and 2 of the drawing, the presently illustrated fuel pump provides a cylinder assembly including a cylindrical frame or housing 10 having a cylinder or pump barrel 11 disposed therein for positionment against an internal annular housing shoulder 12, and a valve cage 13 positioned in axial abutment with the upper end of the cylinder 11, the cylinder and valve cage forming a primary fuel pump chamber 14. The valve cage member 13 is adapted to be retained in operative position within the pump housing 10 by means of the adapter member 15 which is threadedly mounted in the housing 10, in embracing relation to the cage member 13 as shown. The adapter member receives a discharge body element 16 and positions the latter in axial abutment with the valve cage 13, it being noted that the discharge body is held in assembly by means of a pair of split ring elements 17 engaged against a suitable annular shoulder on the body 16 and held by means of a plurality of cap screws 18 threaded into the adapter 15. An eccentric element 19 is employed to determine the position of the body 13 relative to the cylinder 11 for proper alignment of discharge passages therebetween.

A main or primary pump piston 20 is operably disposed for rotational adjustment, and for reciprocation within the cylinder 11 as actuated by a suitable cam (not shown) driven by a rotating part of the associated engine (not shown). Cooperating with the primary piston 20 is an auxiliary piston 21 which extends into an axial bore 22 formed in the upper portion of piston 20, the pistons 20 and 21 defining between them an auxiliary pump chamber 23. In the present arrangement, auxiliary piston 21 is carried by the valve cage member 13 and fixed thereto through the provision of a key-like locking head 24 on the auxiliary piston, seated in a suitable socket 25 formed in the valve cage member 13. The key head 24 is formed preferably as an integral part of the auxiliary piston 21 and is adapted to secure the latter piston in predetermined fixed relation with respect to the main piston 20.

The means provided for attaining angular adjustments of the primary piston 20, includes a transverse control arm 26 formed integrally on the lower portion of the piston 20 and arranged to engage in longitudinally directed slots 27 formed in a control sleeve member 28. The control sleeve 28 is suitably mounted for rotation relative to the lower end of the pump cylinder 11 and has formed thereon a pinion gear 29. Sleeve 28 is retained in the position shown in Fig. 1 by means of a collar 30 and a suitable spring 31 which abuts the collar 30 as shown. Spring 31 may also be utilized as the resilient means for urging a suitable cam actuated follower, not shown, in a downward direction so that the main piston 20 will be caused to follow the driving cam. Rotational adjustment of the sleeve 28 is had through the provision of a control rack 33 suitably mounted for longitudinal movement in the housing 10 as is well understood in this art. Rack 33 is prevented from rotational displacement by means of a suitable set screw 34 engaging in a longitudinal slot 35 formed in the back of the rack 33. Rack 33 meshes with the pinion gear 29 on sleeve 28, so that longitudinal displacement of the rack as in response to engine governor action, effects rotation of sleeve 28 and through the means 26 on the primary piston 20, regulates the angular position of the primary piston.

In the present pump construction the main fuel supply port 40 is formed in the upper zone of the cylinder 11 (Figs. 1, 3 and 4) and opens directly to the primary pump chamber 14. Pressure discharge of fuel from the primary pump chamber 14 is conducted through passage 41 formed in the valve cage member 13, past valve element 42 and through a discharge passage 43 to a conduit (not shown) leading to the engine cylinder injection valve (not shown). Valve member 42 is operably disposed in a suitable chamber 44 provided in discharge body 16, and is urged in a direction to close discharge passage 41, by means of a suitable spring 45. In order to control the timing and quantity of fuel delivery from the main chamber 14, the primary piston 20 is provided with a control element 46 carried on the upper reduced end thereof so that the control element 46 may be angularly adjusted relative to the main fuel inlet port 40 through angular adjustments of the piston, for controlling the point or time in the pumping stroke of the main piston at which the control element closes port 40 and initiates fuel discharge. Referring to Figs. 3 and 5, control element 46 is provided with an inlet port cut-off edge 47 which is of spiral extent, and a bottom edge 48 which is normal to the piston axis. The control element thus provides a port controlling surface between the edges 47 and 48 effective upon angular adjustments of the piston 20, through a given range hereinafter referred to, to determine fuel quantity delivery and variable beginning of delivery dependent upon the relative positions of the inlet port 40 and the spiral control edge 47. In the present embodiment, the angle of wrap of control element 46 is substantially 180° which thus defines between the ends of the element a channel 49 of approximately 180° extent, opening to the piston head end and to the piston recess below the control element. Thus in one range of rotational adjustment of the primary piston 20, the control surface is removed from controlling relation to port 40, and in another range of such adjustment the control element is effective to control port 40 during the reciprocation of the piston.

As before noted, the primary piston 20 is provided with axial bore 22 for the reception of the auxiliary piston 21, whereby these pistons define therebetween an auxiliary pump chamber 23. The fuel supply for chamber 23 is received directly from the primary chamber 14 by way of the relief channel 49 and an inlet port 51 formed in the primary piston 20. Inlet port 51 for chamber 23 is of a predetermined size in order to provide for desired metering of the fuel entering the chamber 23. From chamber 23 the fuel is discharged through a radial discharge port 52 to an annular recess 53 in the primary piston 20, the recess 53 being separated from channel 49 by the annular land 50. From annular recess 53, the fuel is conducted to a radial passage 54 and an axial passage 55 formed in the cylinder member 11. The valve cage member 13 is suitably provided with a passage 56 which has communication with the upper end of cylinder passage 55, passage 56 conducting the auxiliary fuel discharge to valve 57, from which the fuel delivers to the common discharge passage 43. Valve 57 is suitably mounted in a chamber 58 and is urged in a passage closing direction by means of spring 59.

Referring now in particular to the auxiliary piston 21, it will be observed that this piston is provided with a reduced end portion 61, and that a control element 62 is carried or integrally formed on this reduced end extending over approximately 180° of the piston circumference, and in which the distance between the upper and lower spiral edges 63 and 64 respectively, as measured in a direction parallel with the axis of the pump, is constant. The reduced portion of the auxiliary piston between the ends of the spiral control element 62 provides a relief channel communicating the chamber 23 with the inlet port 51. As so provided, the control element 62 in its control of inlet port 51, is adapted for determining a constant quantity delivery of fuel from the auxiliary chamber, with initiation of fuel delivery variable to an extent hereinafter appearing.

In the assembly relationship of the pump parts, the main piston 20 is positioned to relate its control element 46 to the main inlet port 40 such that in angular adjustment of the piston from an initial point through a first range of 180°, the relief passage or channel 49 will remain in alignment with the port 40, thereby precluding fuel delivery from the main chamber 14 to the engine upon displacement of piston 20. Fig. 4 illustrates the relation of the control element 46 to the port 40 when the piston 20 is disposed at the end of its first range of angular adjustment. Further angular adjustments of the main piston beyond the first range and through a second range of 180°, then serves to bring the control element 46 into operative relation to the inlet port 40, as this will appear from Fig. 4 wherein the direction of piston turning is clockwise to bring the control element 46 to a position for port control. Varying the angular position of the piston in the second range correspondingly varies the point of inlet port closure by the spiral cut-off edge 47 in the pumping stroke of the piston, as well as the duration of port closure. Consequently, in the second range of angular adjustment, the piston 20 effects fuel delivery from chamber 14 variable as to quantity and beginning of delivery. With the main piston so related to inlet port 40, the auxiliary piston 21 is fixed in a position such that its control element 62 will be in effective control relation to the inlet port 51 only throughout the first mentioned range of angular adjustment of main piston 20 when no fuel is delivered from chamber 14 to the engine. In this range, the port 51 being in the main piston 20 and hence angularly shifted relative to control element 62 upon angular displacement of the main piston, is disposed for cut-off control by the lower end of the element 62 at the beginning of the first 180° range above stated, thus determining the start of fuel delivery from the auxiliary chamber 23 early in the upstroke of the main piston. As the main piston is adjusted toward the end of the first range, the start of fuel delivery from the auxiliary chamber is correspondingly retarded, occurring later in the upstroke of the main piston to the point of maximum retardation when the main piston is adjusted to the end of the first range. The foregoing described relationship of the main and auxiliary chamber inlet ports and the associated control elements is illustrated diagrammatically by Fig. 6, wherein the arrow indicates clockwise angular displacement of the main piston 20 from its initial position shown.

In use of the pump hereinabove described, on a convertible dual fuel engine for example, when gas operation of the engine is desired the governor control of the pump rack 33 is set to effect angular adjustments of the main piston 20 only through the first range of such adjustment, wherein pressure delivery of fuel from the main chamber 14 does not take place. Now, under light loads the angular adjustment of the main piston 20 is such as to locate the port 51 in longitudinal alignment with the lower end of the control element 62 on auxiliary piston 21, so that in each pumping stroke of the main piston, the inlet port 51 will be cut off early in the stroke, resulting in advanced delivery of a constant quantity of liquid fuel to the engine for ignition of the gaseous fuel admitted to the engine. Early injection of the pilot ignition charge as here obtains under light loading of the engine, has been found to improve very materially, the gaseous fuel consumption factor of the engine. Moreover, it is to be noted here that the quantity of pilot fuel injection which is constant for all adjustments in the time of injection, is desirably limited to an amount just sufficient to assure positive ignition of the gaseous fuel. Limitation of the amount injected is determined as will be now appreciated, by the distance as measured parallel to the axis of the piston 21, between the spiral edges 63 and 64 of the control element 62. As engine loading increases toward full load, the governor effects corresponding angular advances of the main piston 20 toward the end of the first range. This results in a like advance of the port 51 relative to the control element 62, with consequent retardations of pilot injection in the engine cycle such that at full load, the pilot injection is retarded to a maximum extent. Such timing regulation of pilot injection serves to reduce to a minimum or avoid altogether, fuel detonation in the engine operating under heavy loads up to full load capacity.

Upon change-over of the engine from gas operation to operation on liquid fuel alone, as on the diesel cycle, governor adjustment is such as to confine the angular adjustment of the main piston 20 to the second range hereinbefore described. In the pump as so conditioned, it will appear that the inlet port 51 is open to the relief channel between the ends of the control element 62, so that pilot injection of fuel is prevented throughout the second range of angular adjustment of the main piston. The control element 46 on the main piston 20, however, is now in full control of the main inlet port 40, such as to determine the quantity and beginning of fuel delivery from the main chamber 14 responsive to the pumping stroke of the main piston 20.

Having now described an illustrative embodiment of the present invention in application to a convertible dual fuel type engine, it should be appreciated that it is within the concept of the invention to adapt the pump for use with internal combustion engines operating on liquid fuel alone, where improved performance can be achieved by supplying the engine combustion chamber with an initial charge of liquid fuel preceding the supply of a primary liquid fuel charge. That adaptation may be achieved quite readily, as by adjusting the fixed position of the auxiliary piston 21 such as to make the control element 62 effective to determine a pilot delivery of fuel ahead of main fuel delivery in the fuel discharge stroke of the primary piston 20.

It should be understood that the presently described pump structure is susceptible of certain

changes and alterations both as to structure and in its operation, as suggested above by way of example, without departing from the spirit and scope of the annexed claims.

I claim:

1. In a fuel pump, a cylinder providing a pump chamber, pistons in the cylinder relatively adapted and arranged for cooperation to define a second pump chamber, passage means for fuel admission to said second chamber from the first said chamber, said pistons being relatively longitudinally displaceable in the cylinder for effecting fuel admission to and fuel discharge from the pump chambers, and said pistons further being relatively angularly displaceable in the cylinder and adapted for regulating the beginning of fuel discharge from the chambers in accordance with relative angular positions of the pistons.

2. In a fuel pump, a cylinder providing a pump chamber, telescopically related pistons in the cylinder cooperating to define a second pump chamber in one piston, passage means for fuel admission to said second chamber from the first said chamber, the pistons being relatively longitudinally displaceable for effecting fuel admission to and fuel discharge from the chambers, and said pistons further being relatively angularly adjustable in the cylinder and adapted for effecting in accordance with relative angular adjustments of the pistons, variations in the timing of fuel discharge in the relative pumping stroke of the pistons.

3. In a fuel pump, a cylinder providing a pump chamber, telescopically related fixed and movable pistons in the cylinder cooperating to define a second pump chamber in one of the pistons, said movable piston serving through displacements thereof relative to the fixed piston, for effecting fuel admission to and fuel discharge from the chambers, said movable piston further being angularly adjustable in the cylinder and adapted for effecting in accordance with angular adjustments thereof through a predetermined range, variations in the timing and quantity of fuel discharge from the first said pump chamber, and said fixed piston being adapted for effecting in accordance with angular adjustments of the movable piston through another range, variation in the timing of fuel discharge from said second pump chamber.

4. In a fuel pump, a cylinder assembly providing a pump chamber having fuel inlet and discharge passages, relatively displaceable pistons in the cylinder defining a second pump chamber therebetween, fuel inlet and outlet means for said second chamber, said second chamber fuel inlet means being in fuel receiving communication with the first said pump chamber, one of said pistons being operable to effect fuel discharge from the first said chamber through said discharge passage, and said pistons being operable through relative displacement thereof, to effect fuel discharge from said second chamber through said outlet means.

5. In a fuel pump, a cylinder assembly providing a main pump chamber having a fuel admission port and a discharge port, relatively displaceable pistons in the cylinder adapted to define an auxiliary pump chamber therebetween, passage means communicating said main and auxiliary chamber for fuel admission to the auxiliary chamber from the main chamber, fuel discharge passage means open to the auxiliary chamber, one of said pistons being operable to control fuel admission to and discharge from said main chamber, and said pistons cooperating through relative displacements thereof, to control fuel admission to and discharge from said auxiliary pump chamber.

6. In a fuel injection pump, a cylinder assembly providing a main pump chamber having fuel inlet and discharge ports, means providing a discharge passage leading from the discharge port, relatively displaceable pistons in the cylinder cooperating to define an auxiliary pump chamber therebetween, passage means intercommunicating said main and auxiliary chambers for fuel delivery from the main to the auxiliary chamber, and fuel outlet passage means leading from the auxiliary chamber to said discharge passage, one of said pistons being operable to control fuel admission to and discharge from said main chamber, and said pistons cooperating through relative displacements thereof, to control fuel admission to and discharge from the auxiliary chamber.

7. In a fuel injection pump, a cylinder assembly providing a main pump chamber having fuel admission and discharge ports, relatively displaceable pistons in the cylinder in telescopic relation defining an auxiliary pump chamber therebetween, passage means for fuel admission to the auxiliary chamber from the main chamber, and discharge passage means leading from the auxiliary chamber, one of said pistons being operable for controlling fuel admission to and discharge from the main chamber, and the pistons cooperating through relative telescopic displacements thereof, to control fuel admission to and discharge from the auxiliary chamber.

8. A fuel injection pump comprising a cylinder assembly providing a main pump chamber having fuel inlet and discharge ports, a piston reciprocable in the cylinder for controlling fuel admission to and fuel discharge from the main chamber, a second piston fixed in the cylinder and cooperating with the first said piston to define an auxiliary pump chamber, fuel inlet and discharge passage means for the auxiliary chamber, the auxiliary chamber fuel inlet passage means communicating with said main pump chamber, and said pistons coacting through reciprocation of the first said piston, to control fuel admission to and fuel discharge from the auxiliary chamber.

9. A fuel injection pump comprising a cylinder assembly providing a main pump chamber having fuel inlet and outlet ports, fuel discharge passage means leading from the outlet port, a piston reciprocable in the cylinder for controlling fuel admission to and fuel discharge from the main chamber, a second piston fixed in the cylinder and cooperating with the first said piston to define an auxiliary pump chamber, fuel admission means for the auxiliary chamber, and a fuel outlet means extending from the auxiliary chamber to said fuel discharge passage means, said pistons coacting through reciprocation of the first said piston, to control fuel admission to and fuel discharge from the auxiliary chamber.

10. A fuel injection pump comprising a cylinder assembly providing a main pump chamber having a fuel inlet and a fuel discharge passage opening to the chamber, a piston reciprocable in the cylinder and angularly adjustable therein, adapted for determining fuel quantity discharge from the main chamber in accordance with angular positionment of the piston, a second piston fixed in the cylinder and cooperating with the first said piston to form an auxiliary pump cham-

ber within the latter, passage means for admitting fuel to the auxiliary chamber from the main chamber, and fuel discharge passage means between the auxiliary chamber and said fuel discharge passage for the main chamber, said pistons coacting through reciprocation of the first said piston, to control fuel admission to and fuel discharge from the auxiliary chamber.

11. A fuel injection pump comprising a cylinder assembly providing a main pump chamber having a fuel inlet and a fuel discharge passage opening to the chamber, a piston reciprocable in the cylinder and angularly adjustable therein, adapted for determining fuel quantity discharge in accordance with angular positionment of the piston, said piston having an axial bore, a second piston fixed in said cylinder and extending in said axial bore, cooperating with the first said piston to form an auxiliary pump chamber in the bore, the first said piston being provided with fuel admission and discharge ports for the auxiliary chamber, passage means connecting said discharge port and said discharge passage, and a control element on said second piston adapted and arranged for controlling closing of the auxiliary chamber admission port during pumping displacement of the first said piston.

12. A fuel injection pump comprising a cylinder assembly providing a main pump chamber having a fuel inlet and a fuel discharge passage leading from the chamber, a piston longitudinally movable in the cylinder and angularly adjustable therein, adapted for determining fuel quantity discharge from the main chamber in accordance with the angular positionment of the piston, said piston being provided with an axial bore, a second piston fixed in the cylinder and extending in said axial bore of the first said piston, cooperating with the latter piston to form an auxiliary pump chamber in said bore, the first said piston having a fuel inlet port for the auxiliary chamber and a passage-forming recess communicating said inlet port with the main pump chamber, the first said piston further providing a discharge port open to the auxiliary chamber, passage means in the cylinder connecting said discharge port with said fuel discharge passage, and a control element on the second piston adapted and arranged for closing said fuel inlet port to the auxiliary chamber at a point in the pumping stroke of the movable piston determined by the angular positionment of the movable piston.

13. A fuel injection pump comprising a cylinder assembly providing a main pump chamber having a fuel inlet port and a fuel discharge passage leading from the chamber, a piston reciprocable in the cylinder and angularly adjustable therein, said piston being of reduced diameter in its head end and providing an inlet port control element on said end effective in pumping displacement of the piston, to determine fuel quantity discharge from the main chamber in accordance with the angular positionment of the piston, a second piston fixed in the cylinder, said pistons being telescopically related and forming an auxiliary pumping chamber within the first said piston, inlet passage means between the main and auxiliary chambers for the admission of fuel to the latter chamber, cooperating passage means in the first said piston and the cylinder for the discharge of fuel from the auxiliary chamber, and a control element on said second piston effective in the pumping displacement of the first said piston, for controlling fuel discharge from the auxiliary chamber in accordance with the angular positionment of the first said piston.

14. A fuel injection pump for selective delivery of primary and pilot fuel charges, comprising a cylinder assembly providing a main pump chamber having an inlet port and a discharge passage leading from the chamber, a main piston reciprocable in the cylinder and angularly adjustable therein selectively through a first angular range and through a second angular range, an inlet port control element on the piston effective solely in said second range of angular adjustment of the piston, to determine variable quantity fuel delivery from the main pump chamber in the pumping operation of the piston, an auxiliary piston in the cylinder and cooperating with the main piston to form an auxiliary pump chamber, means including an inlet port for admitting fuel to the auxiliary chamber, discharge passage means leading from the auxiliary chamber, and a control element on the auxiliary piston for controlling the inlet port of the auxiliary chamber, effective solely in the first range of angular adjustment of the main piston, to determine fuel delivery from the auxiliary chamber in the pumping operation of the main piston.

15. A fuel injection pump comprising a cylinder assembly providing a main pump chamber having an inlet port and a discharge passage leading from the main chamber, a main piston reciprocable in the cylinder and angularly adjustable therein selectively through first and second angular ranges, said piston being formed to provide an inlet port control element effective in angular adjustment of the piston through said second range, to determine variable quantity delivery of fuel from the main chamber in the pumping operation of the piston, said piston further having a relief channel effective relative to said inlet port upon angular adjustment of the piston in said first range, to prevent fuel delivery from the main chamber, an auxiliary piston in the cylinder telescoped in the main piston and cooperating with the latter to form an auxiliary pump chamber, said main piston providing an auxiliary chamber inlet port in communication with said relief channel for the admission of fuel to the auxiliary chamber from the main chamber, discharge passage means extending from the auxiliary chamber to said discharge passage leading from the main chamber, and a control element on the auxiliary piston for controlling the inlet port of the auxiliary chamber, effective solely in the first range of angular adjustment of the main piston, to determine constant quantity fuel delivery from the auxiliary chamber in the pumping operation of the main piston.

16. A fuel pump as defined by claim 15, wherein said control element on the auxiliary piston is arranged and adapted for controlling the inlet port of the auxiliary chamber such as to determine initiation of fuel delivery from the auxiliary chamber at a time in the pumping stroke of the main piston dependent upon the angular position of the main piston in said first range of angular adjustment thereof.

17. A fuel pump as defined by claim 15, wherein said auxiliary piston is fixed in the cylinder against longitudinal displacement therein.

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