June 23, 1942. D. B. BAKER ET AL 2,287,407

FUEL PUMP

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FIG. 2

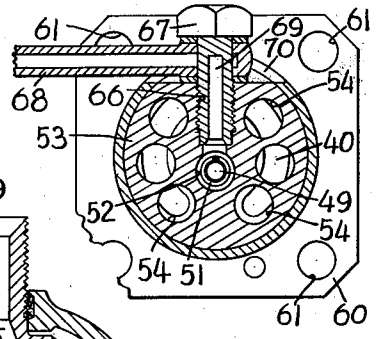


FIG. 1

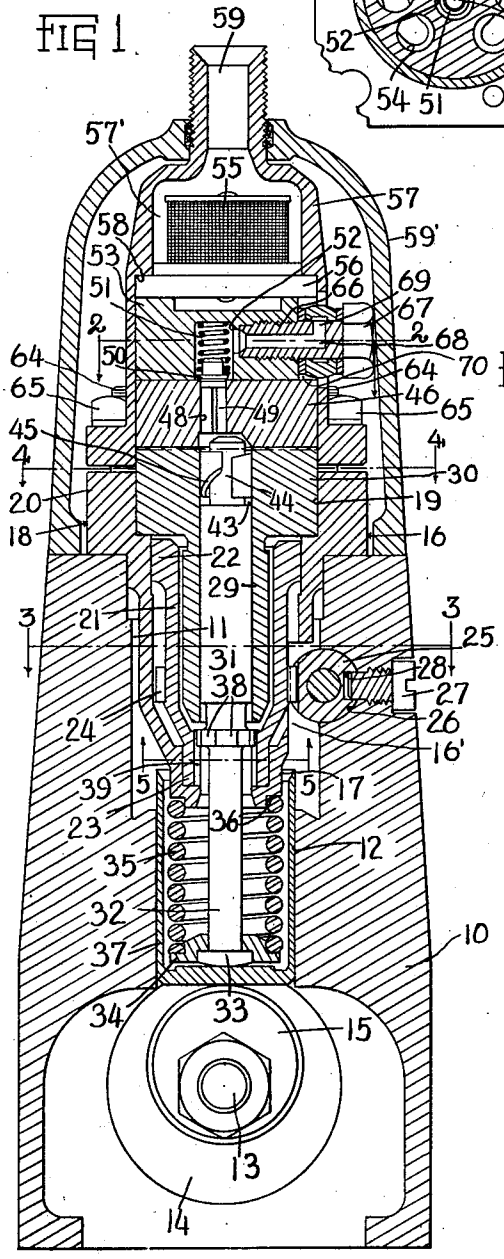


FIG. 3

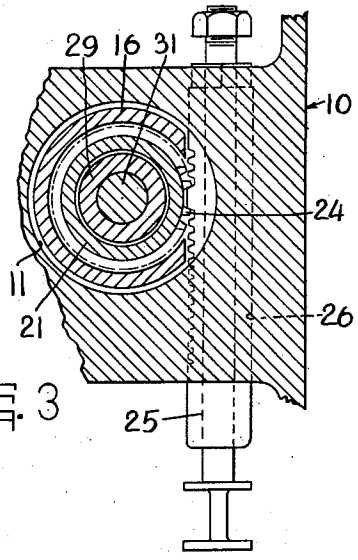


FIG. 4

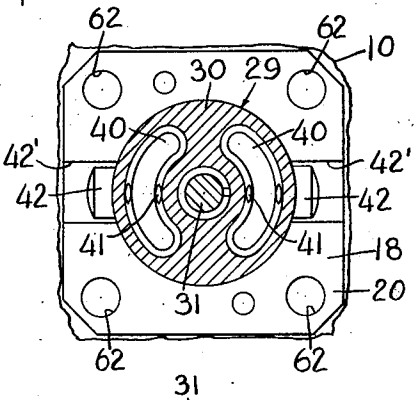
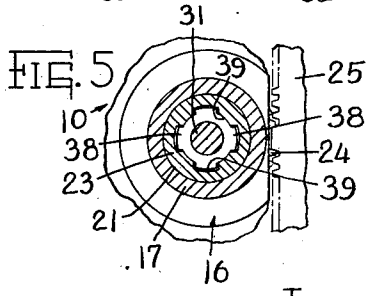


FIG. 5



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FIG. 6

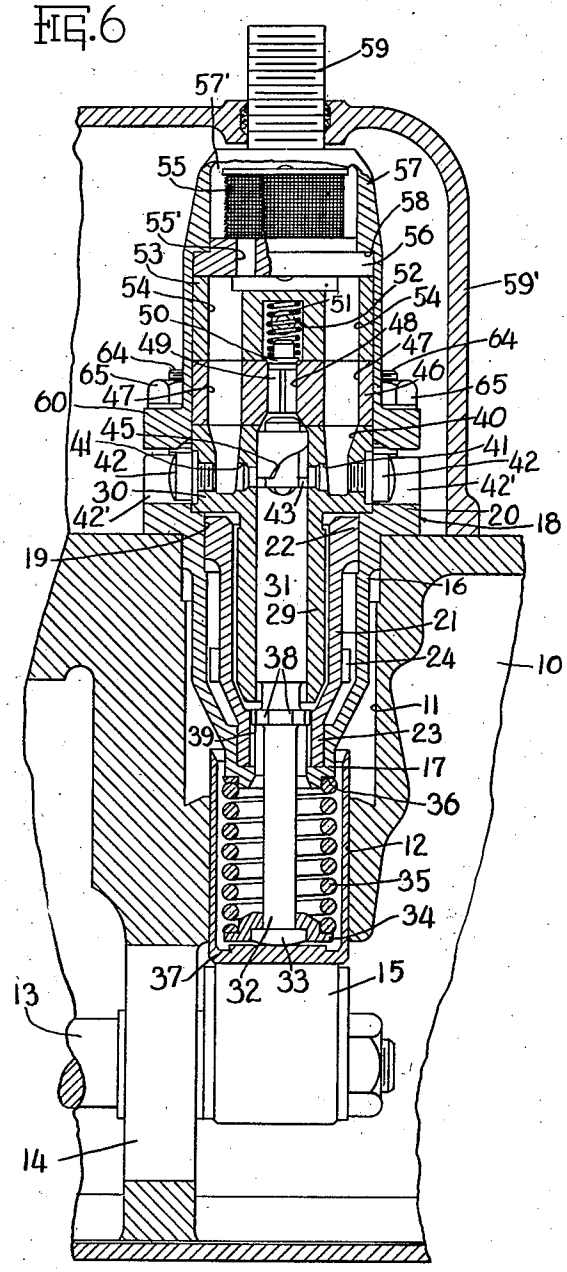
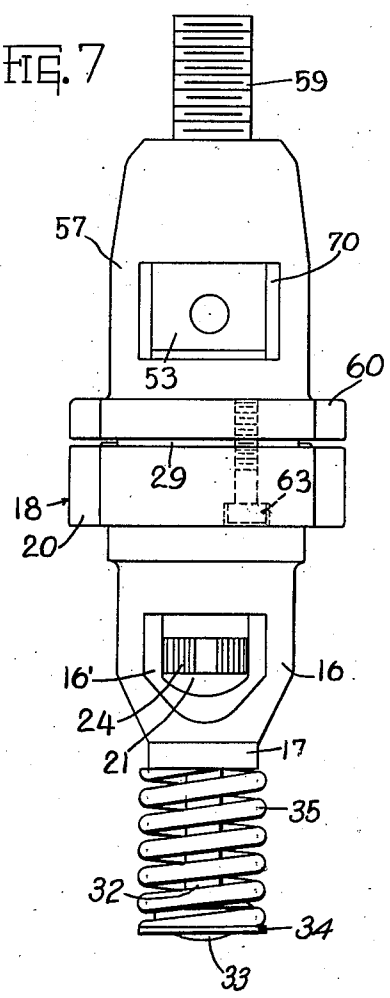


FIG. 7



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2,287,407

FUEL PUMP

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Application April 20, 1940, Serial No. 330,749

13 Claims. (Cl. 103—41)

The present invention relates to an injection pump for internal combustion engines. More particularly, it relates to that type of pump in which the piston has a controlling face regulating communication of the cylinder with ports in the wall thereof, and to mechanism for regulating the position of the piston.

The principal object of the present invention is to provide an improved unit type of construction for an injection pump of the piston controlled port type.

Another object is to provide an improved regulating means for controlling the piston position in a pump of said type.

The above objects, and others which will be apparent from the detailed description to follow, are attained by a construction such as shown in the drawings, in which—

Figure 1 is a transverse, vertical section through a pump incorporating an injection plunger unit embodying the invention;

Figure 2 is a section taken on the line 2—2 of Figure 1;

Figure 3 is a section taken on the line 3—3 of Figure 1;

Figure 4 is a section taken on the line 4—4 of Figure 1;

Figure 5 is a section taken on the line 5—5 of Figure 1;

Figure 6 is a vertical section longitudinally of the pump casing taken through the center line of the injection plunger unit.

Figure 7 is an elevation of the injection plunger unit removed from the casing.

The injection plunger unit including the controlling means therefor, as illustrated in the drawings, may be utilized for single or multiple cylinder pumps, or for pumps having a single pressure supplying unit and a plurality of distributor valves for supplying the fuel charges to a plurality of engine cylinders. Such a pump is shown in the co-pending application Serial No. 330,750, filed April 12, 1940, which covers the use of a pump unit of this type in a particular fuel injection system. Only such parts of the pump casing and the fuel supply and discharge conduits as are necessary to adequately show the subject-matter of this invention are shown.

A pump casing 10, which is constructed as a casting, is provided with a vertical bore 11 extending from the upper end of the casing, and a vertical bore 12, coaxial with respect to the bore 11, extending downwardly into the interior of the casing. A plunger driving shaft 13 is shown as being mounted at one end in a ball-bearing assembly 14, diagrammatically illustrated. Said shaft is provided with an eccentric 15 for driving the plunger of the injection unit.

A supporting sleeve member 16 is slidably fitted at its upper end into the upper portion of the bore 11, being spaced from said bore beyond the closely fitted portion and being formed with a lower end portion 17 substantially less in diameter than the bore 11. Said member is provided with a head portion 18, which is seated on the top surface of the casting forming the casing 10. Said upper portion is provided with a bore 19 substantially larger in diameter than the internal diameter of the upper portion of the sleeve, forming thereby a shoulder 20.

A piston control member 21 is mounted within the sleeve member 16, being provided with an upper bearing portion 22 journaled in the upper portion of the sleeve member and a lower bearing portion 23 journaled in the lower reduced end portion 17 of the sleeve member. The outside diameter of the member 21 is substantially less than the internal diameter of the sleeve 16 between the axially spaced bearing portions 22 and 23. Gear teeth 24 are formed on the member 21 intermediate the bearing portions. The sleeve member 16 is cut away at one side, as shown in Figure 1 and Figure 7, forming an opening 16' to provide access to the gear teeth 24 for engagement therewith of a control member in the form of a rack member 25. Said rack member is cylindrical and is fitted in a bore 26 extending lengthwise of the casing 20. The rack member is held against rotation by a set screw 27 threaded into a bore in the casing and slidably engaging a groove 28 in the rack member. Any suitable manual or governor means, many of which are old in the prior art, may be utilized for reciprocating the rack-member 25 for regulating the angular position of the piston control member 21.

A cylinder member 29 is suspended within the control member 21 out of contact therewith. Said member is provided with a head portion 30 fitted within the bore 19 and abutting the shoulder 20 of the head portion 18 of the sleeve member. It will be noted that clearance has been shown between the upper end of the control member 21 and the lower surface of the head portion 30 to indicate that the control member 21 is free to rotate on its bearings 22 and 23 without any axial pressure thereon.

An injection piston, or plunger, 31 is mounted for reciprocation in the cylinder member 29. Said plunger is provided with a lower stem extension 32 which is formed with a head 33. A re-

tainer 34 seated on the head 33 provides an abutment for a compression spring 35. The other end of said spring abuts a shoulder 36 formed at the reduced end portion 17 of the sleeve member 16. A tappet cup 37, slidably and rotatably mounted in the bore 12, is adapted to be engaged by the eccentric 15 for actuating the piston 31 by engagement with the head 33 thereof. It will be noted that the tappet cup 37 is of larger internal diameter than the outside diameter of the reduced end portion 17 of the sleeve member. This permits overlapping of said members and reduces the overall height of the injection unit, which is an important consideration in the design of injection pumps.

The piston 31 is provided, below the lower end of the cylinder member 29, with a plurality of driving lugs 38, best shown in Figure 1 and Figure 5. Said lugs are adapted to reciprocate in spline-like channels 39 formed at the lower end of the control member 21. The lugs 38 are fitted with a minimum clearance in the channels 39 to reduce any slight angular movement of the piston relative to the control member to a minimum while at the same time providing axial movement of said members relative to each other with a minimum of friction. By this construction, movement of the rack member 25 oscillates the piston 31 for controlling the effective injection stroke as will be hereinafter described.

Referring to Figures 4 and 6, the head portion 30 of the cylinder member 29 is provided with a pair of diametrically spaced arcuate recesses 40 extending downwardly from the upper face thereof. Bores 41 extending radially inwardly from the outer cylindrical wall of said head portion intersect the recesses 40 and extend into the cylinder. Cap screws 42 are threaded into the outer ends of the bores to seal them against fuel leakage. In the particular construction illustrated, it is necessary, in order to form the useful inside portions of the bores, to bore through from the outside wall. The heads of the screws 42 are fitted in recesses 42' in the flanged portion 18 of the sleeve 16. It will be noted that the recesses of the bores 41 are countersunk. This construction is provided to attain the desired flow characteristics into and out of the cylinder.

The piston 31 has a head portion of a conventional construction such as is utilized for regulating the discharge quantity of a reciprocating plunger by utilizing the piston as a valve. An annular recess 43, formed around the piston and spaced from the head thereof, communicates with a vertical channel 44 extending upwardly from the recess or channel 43 to the top of the piston. An angularly disposed wall 45 joins the two channels 43 and 44 at an angle thereto. The shape of said curved wall is carefully determined in order to give the desired control of the quantity of fuel injected during movement of the rack member 25. Both of the ports 41, when located in alinement as illustrated, serve as inlet ports while only the one plate over by the curved wall 45 acts as a by-pass port.

A spacer member 46 of the same outside diameter as the head portion 30 of the cylinder member is mounted thereon. Said member is provided with ports 47 communicating with the recesses 40 and with a substantially centrally located bore 48 communicating with the cylinder. A valve 49 is mounted in said bore, the head portion 50 of the valve being seated on a co-operating seat formed around the upper end of the bore 48. A valve spring 51 abutting the valve and acting to hold it in closed position until the desired pressure is attained in the cylinder, is located in a closed end bore 52 formed in a second spacer member 53. Said second spacer member is also provided with bores, or ports, 54 communicating with the ports 49 to supply fuel to the recesses 40.

A filter unit 55 having a flange 56 of the same outside diameter as the spacer members, is mounted on the upper end of the upper spacer member. As illustrated by the cut-away section at one side of the filter unit in Figure 6, fuel passes radially in through the filtering surface and downwardly through openings 55', one of which is shown, into the bores 54.

A cover member 57 is provided with an internal bore of the same diameter as the outside diameter of the spacer members 46 and 54. Said member is fitted downwardly over the spacer members with a shoulder 58 abutting the upper surface of the filter unit flange 56. Above said shoulder, an inlet compartment 57' provides for location of the filter unit. A threaded extension 59 on the cover member extends upwardly through a cover 59' mounted on the casing 20 merely for the purpose of protecting the parts of the pump unit. The extension 59 is formed with an internal conduit to which fuel is supplied by means of a suitable fitting, not shown, connected to the extension.

The cover member 57 is provided with a flange 60 which, as shown in Figure 2, is provided with four openings 61 in alinement with four corresponding openings 62, as shown in Figure 4, in the flanged portion 18 of the sleeve member 16. As shown in Figure 7, the flange 60 is secured to the flanged portion 18 by cap screws 63, one of which is shown. Said cap screws hold the two closing parts of the plunger unit in assembled relation forming thereby a unit which can be removed as such from the pump casing. The actual clamping pressure effective to hold the internal parts of the unit together, is obtained by studs 64 threaded into the casing 10 and extending upwardly therefrom through the alined openings 61 and 62. Nuts 65 on the studs provide means for clamping the fitted parts of the plunger unit together in assembled relation on the pump casing.

To provide a fuel discharge means for the fuel delivered under pressure from the injection pump past the valve 49, a transverse bore 66 communicates with the bore 52. The other end of said bore is threaded to receive a cap screw 67 which is utilized to clamp one end of a fuel conduit member 68 against a flattened wall portion of the spacer member 53. This type of connection is conventionally used where an adequate seal is required for fluids under very high pressure. The conduit within the member 68 communicates with a bore 69 formed axially through the cap screw 67 from the inner end and terminating on a radial portion near the head end. As shown best in Figures 1, 2, and 7, the cover member 57 is cut away at one side forming an opening 70 to provide clearance for connecting the conduit member 68 to the spacer member 53.

As shown in Figures 3 and 5, a gear tooth is omitted from the gear teeth 24 formed on the control member 21 and the corresponding space on the rack member 25 is filled in solid forming a tooth of three times the width of the other teeth. This construction is utilized for assuring fitting of the plunger unit into the casing with the desired timing relation between the control member and the piston. Otherwise, there would be

four possible positions of the piston relative to its control member due to the use of four driving lugs, as shown in Figure 5.

The operation of the parts making up the pump, as above described, has been explained to a considerable extent in connection with the description of the elements. Fuel supplied, usually under a constant low pressure, to the extension **59** of the cover member **57** passes through the filtering element **55**, the vertical bores, or ports, **54** and **47** in the spacer members **53** and **46** to the recesses **40**. From said recesses, fuel is taken into the cylinder and metered by the angular position of the piston to discharge one portion of the fuel taken into the cylinder at high pressure through the discharge valve **49**, and to by-pass the remainder of the fuel back into the inlet side of the system.

In the operation of the pump, the angular or plunger position is controlled by the member **21** as oscillated by the rack member **25**. Said member being provided with bearing portions spaced axially a considerable distance, can be mounted for free rotation without encountering any possible cocking due to action of the rack against one side thereof. The driving connection between the control member and the piston is such that a relatively large wearing surface is provided with the result that wear is reduced to a minimum.

Due to the reduced diameter of the lower end of the sleeve member **16**, the unit may overlap the tappet cup **37** permitting the use of a long bearing surface for said cup without necessitating an undesirably large vertical dimension of the pump unit. By providing the cut-away slot, or cut-away portion, **16'** in the sleeve member **16**, it is possible, because of the smaller diameter of the lower portion of said member, to remove the entire structure as a unit without removing or otherwise disengaging the rack member **25**. This is an important feature which permits the removal of the plunger injection unit in the field for service or replacement. As previously pointed out, the cap screws **63** hold the component parts of the unit together while the studs **64** provide means for applying the pressure required to clamp the parts together for actual operation.

The construction of the upper portion of the unit is such that the cover member **57** may be cut away to provide for connection of the conduit member **68** with the spacer member **53**. This is possible as the seal for low pressure is maintained on the flange **56** of the filter unit and the seal for high pressure is maintained between the lower spacer member and the upper surface of the piston member.

It will be understood that applicants have shown only a preferred embodiment of their improved plunger unit and adjustment therefor for fuel injection pumps, and that they claim as their invention all modifications falling within the scope of the appended claims.

What is claimed is:

1. In injection fuel pump construction and in combination a sleeve having a shoulder at one end thereof and an internal bearing portion, a piston control member rotatably mounted in said sleeve, said member having an external bearing portion journaled in the bearing portion of the sleeve, said member having gear teeth formed thereon and said sleeve being provided with an opening at the side thereof for engagement of a driving member with said gear teeth, and a cylinder depending in the control member in spaced relation with respect thereto, and having a flanged head portion mounted on the shoulder of said sleeve.

2. In injection fuel pump construction and in combination a sleeve having a shoulder at one end thereof and spaced continuous internal bearing portions, a piston control member rotatably mounted in said sleeve, said member having spaced continuous external bearing portions journaled in the respective bearing portions of the sleeve, said member having gear teeth formed thereon between the bearing portions and said sleeve having a side portion cut away between the bearing portions to provide for engagement of a driving member with said gear teeth, and a cylinder depending in the control member in spaced relation with respect thereto, and having a flanged head portion mounted on the shoulder of said sleeve.

3. In a fuel injection pump construction and in combination a sleeve having a shoulder at one end thereof and spaced continuous bearing portions, a piston control member rotatably mounted in said sleeve, said member having spaced bearing portions journaled in the respective bearing portions of the sleeve, said member having a segment of a gear formed thereon between the bearing portions and said sleeve having a side portion cut away to provide for a driving member engageable with said gear teeth, the outside diameter of said gear segment being larger than the outside diameter of the lower portion of the sleeve and a cylinder depending in the control member in spaced relation with respect thereto and having a flanged head portion seated on the shoulder of said sleeve, said head portion of the cylinder being provided with a fuel supply means extending from the upper surface thereof into the bore of the cylinder.

4. In a fuel injection pump, a casing structure having a bore therein, a cylinder mounted in said bore, the cylinder being substantially smaller in outside diameter than the diameter of the bore, said cylinder being secured at its upper end only to the casing structure, a piston adjustment member mounted in the space between the cylinder and the inner wall of the casing structure, said member being spaced from the cylinder and being provided with a bearing portion journaled in the casing, a piston mounted for rotation and reciprocation in said cylinder, means for connecting the piston to the control member for rotation therewith and for reciprocation relative thereto, and control means mounted in the casing structure in engagement with the adjustment member.

5. In a fuel injection pump, a casing having a bore therein, a cylinder mounted in said bore, the cylinder being substantially smaller in outside diameter than the diameter of the bore, said cylinder being secured at its upper portion to the casing, a piston adjusting member mounted in the space between the cylinder and the inner wall of the casing, said member being spaced from the cylinder provided with continuous spaced bearing portions journaled in the casing at two spaced locations and with a gear intermediate the bearing portions, a piston mounted for rotation and reciprocation in said cylinder, means for connecting the piston to the adjusting member for rotation therewith and for reciprocation relative thereto, and a control rack mounted for reciprocation in the casing in engagement with the gear on the adjusting member.

6. In a fuel pump, an injection plunger unit comprising a sleeve having a head portion, a piston control member rotatably mounted in said sleeve, a cylinder having a flanged head portion and depending in the control member in spaced relation with respect thereto, the head portion of said sleeve being provided with a recess in which the flanged head portion of the cylinder is seated, said head portion being provided with fuel supply means extending into the bore of the cylinder, a ported spacer member mounted above the flanged head portion of the cylinder, said member being provided with a central bore in communication with the cylinder and a second bore in communication with the fuel supply means of the cylinder, a second ported spacer member mounted above the first spacer member said second member having a vertical bore extending upwardly therein from the lower face in alinement with the central bore of the first mentioned member and a second bore in communication with the second bore of the first mentioned member, said second member being also formed with a transverse bore communicating with the vertical bore, a housing member fitted over both the spacer members and secured rigidly to the sleeve member, said housing having a bore for receiving fuel and delivering it to the second bore of the second spacer member, a piston mounted for reciprocation in the cylinder, said piston being formed with a plurality of driving lugs and said piston control member being provided with a plurality of interengaging lugs whereby said piston is mounted for rotation with the control member and for reciprocation with respect thereto, and means for securing the sleeve and the housing member together whereby all of said elements form a removable unit.

7. In a fuel pump, an injection plunger unit comprising a sleeve having axially spaced, internal bearing portions of different diameters, a piston control member rotatably mounted in said sleeve, said member having bearing portions journaled in the respective bearing portions of the sleeve, said member having gear teeth formed thereon and said sleeve having a side portion cut away to provide for a driving member engageable with said teeth, a cylinder depending in the control member in spaced relation with respect thereto and having a flanged head portion mounted on the said sleeve, said head portion being provided with a fuel supply recess extending downwardly from the upper surface thereof, the head portion of the cylinder being formed with a bore intersecting the recess and extending into the bore of the cylinder, a spacer member mounted above the flanged head portion of the cylinder, said member being provided with a bore communicating with the recess and a bore in communication with the cylinder, said member being also formed with a transverse bore communicating with the vertical bore and a fuel supply bore communicating with the fuel supply recess, a housing member fitted over the spacer member and secured rigidly to the sleeve member, said housing member having a bore for receiving fuel and delivering it to the fuel supply bore in the spacer member, a piston mounted for reciprocation in the cylinder, said piston being formed with a spiral cut-off edge for metering the amount of fuel delivered, slidable engaging means on the piston and on the control member whereby said piston is mounted for rotation with the control member and for reciprocation with respect thereto, the bottom end of the piston being formed with a head, a spring retainer mounted on said head, and a compression spring abutting said retainer and the lower end of the sleeve member whereby all of said elements form a removable unit.

8. In a fuel pump, an injection plunger unit comprising a sleeve having a head portion axially spaced internal bearing portions of different diameters, a piston control member rotatably mounted in said sleeve, said member having bearing portions journaled in the respective bearing portions of the sleeve, said member having gear teeth formed thereon and said sleeve having a side portion cut away to provide for engagement of a control means with said teeth, a cylinder having a flanged head portion and depending in the control member in spaced relation with respect thereto, the flange of the head portion of said sleeve being provided with a centering recess in which the flanged head portion of the cylinder is seated, said head portion being provided with a fuel supply recess extending downwardly from the upper surface thereof, the head portion of the cylinder being formed with a bore intersecting the recess and extending into the bore of the cylinder, a spacer member mounted above the flanged head portion of the cylinder, said member being provided with a bore communicating with the recess and a second bore in communication with the cylinder, a second ported spacer member mounted above the first spacer member, said second member being formed with a vertical bore and with a transverse bore communicating with the vertical bore, said member being also provided with a second bore communicating with the second bore in the first named spacer member, a flanged housing member fitted over both the spacer members and secured rigidly to the flanged portion of the sleeve member, said housing member having a bore for receiving fuel, a piston mounted for reciprocation in the cylinder, slidable engaging means between the piston and the control member, the bottom end of the piston being formed with a head, a spring retainer mounted on said head and a compression spring abutting said retainer and the lower end of the sleeve member whereby all of said elements form a removable injection unit and a tappet cup in which said spring extends, said cup extending upwardly over the lower smaller end portion of the sleeve member.

9. In a removable fuel injection plunger unit the combination of two housing members, one of said members having an end portion of reduced diameter, means for clamping said members together, a cylinder mounted within the member having the end portion of reduced diameter and extending therein in spaced relation thereto, a piston mounted for reciprocation and rotation in said cylinder and extending downwardly through the housing member, a piston control member mounted for rotation between the cylinder and the housing member, said control member having a gear formed thereon of a diameter larger than the reduced diameter end portion of the housing member and said member being cut away to provide an opening for engagement of control means with said gear.

10. A removable fuel injection plunger unit comprising two housing members, one of said members having an end portion of reduced diameter, means for clamping said members together, a flanged cylinder mounted within the members and depending downwardly in the

member having the reduced diameter end portion in spaced relation thereto, a piston mounted for reciprocation and rotation in said cylinder and extending downwardly through the housing member, a piston control member mounted for rotation in said housing member between the cylinder and the member, said control member having a gear formed thereon of a diameter larger than the reduced diameter end portion of the housing member and said housing member being cut away to provide for engagement of control means with said gear, connecting means between said member and the piston providing for relative reciprocation and angular rotation together, means for delivering fuel to the upper housing member, and means within the other housing member for delivering fuel to and from the cylinder.

11. A removable fuel injection plunger unit comprising an upper housing member, a lower housing member having a lower end portion of reduced diameter, means for clamping said members together, a flanged cylinder mounted in the lower member and depending downwardly therein in spaced relation thereto, a piston mounted for reciprocation and rotation in said cylinder and extending downwardly through the housing member, a piston control member mounted for rotation in the lower housing member between the cylinder and the housing member, said control member having a gear formed thereon of a diameter larger than the reduced diameter end portion of the housing member and said housing member being cut away to provide for engagement of control means with said gear, connecting means between said member and the piston providing for relative reciprocation and angular rotation together, means for delivering fuel to the upper housing member, and means within the said upper housing member for delivering fuel to and from the cylinder.

12. In a removable fuel injection plunger unit, the combination of two housing members, one of said members having an end portion of reduced diameter, means for clamping said members together, a cylinder mounted within the member having the end portion of reduced diameter, said cylinder having a head portion fitted in the member and a portion of smaller diameter extending therein in spaced relation thereto, a piston mounted for reciprocation and rotation in said cylinder and extending downwardly through the housing member, a piston control member mounted for rotation in the housing member and spaced from the cylinder, said control member having a gear segment formed thereon of a diameter larger than the reduced end portion of the housing member, said member being cut away adjacent the segment to provide for engagement of control means with said gear.

13. In a removable fuel injection plunger unit, the combination of two housing members, one of said members having a uniform diameter bore therein and an end portion beyond the bore of reduced diameter, means for clamping said members together, a cylinder mounted within the member having the end portion of reduced diameter and extending therein in spaced relation thereto, a piston mounted for reciprocation and rotation in said cylinder and extending downwardly through the housing member, a piston control member mounted for rotation between the cylinder and the housing member, said control member having a gear segment formed thereon of a diameter smaller than the internal diameter of the housing member and larger than the outside diameter of the reduced end portion of the housing member, said member being cut away adjacent the segment to provide for engagement of control means with said gear.

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