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3,277,828

INJECTION PUMP

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2 Sheets-Sheet 1

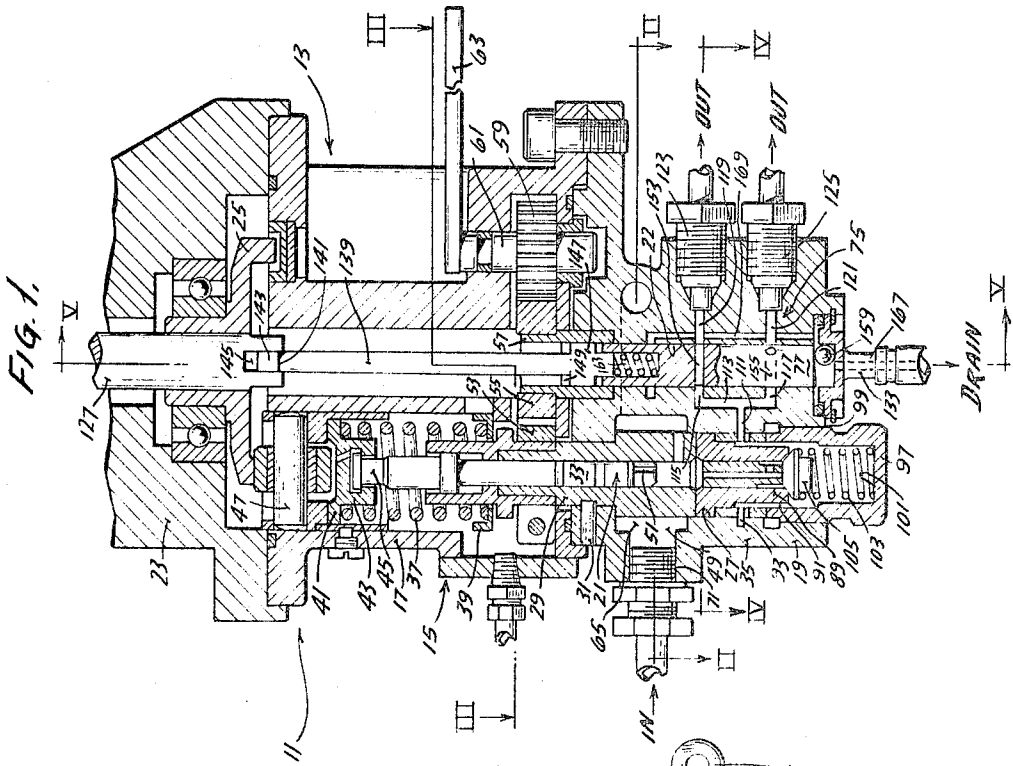


FIG. 1.

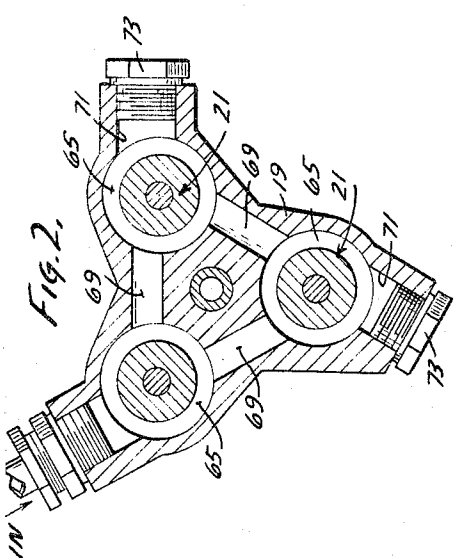


FIG. 2.

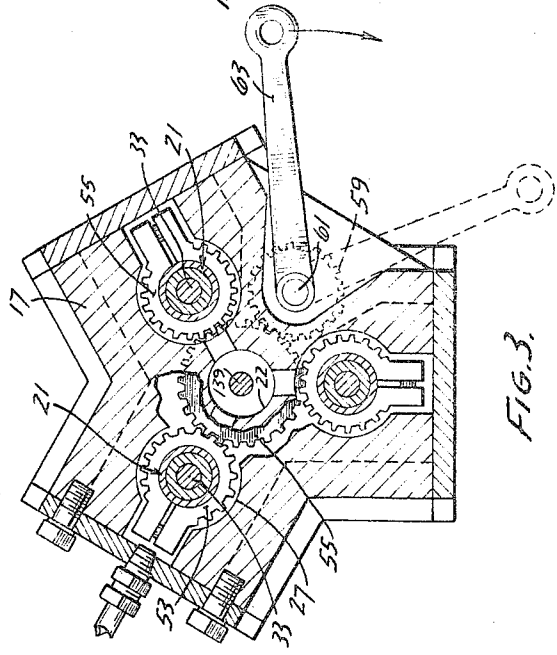


FIG. 3.

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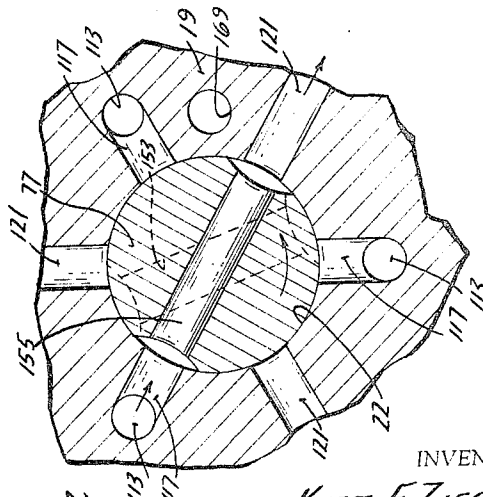
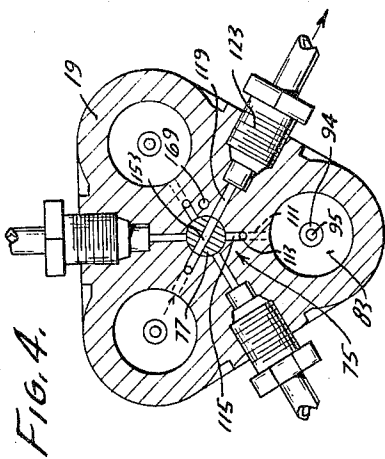
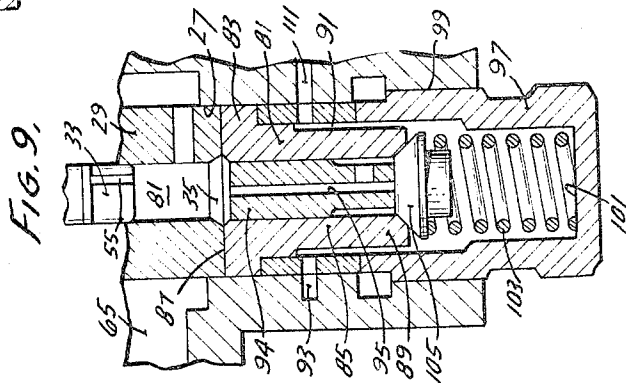
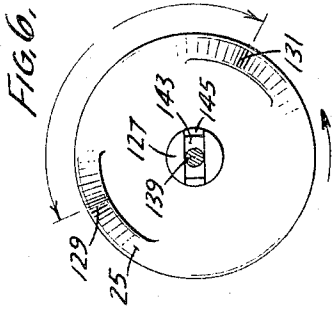
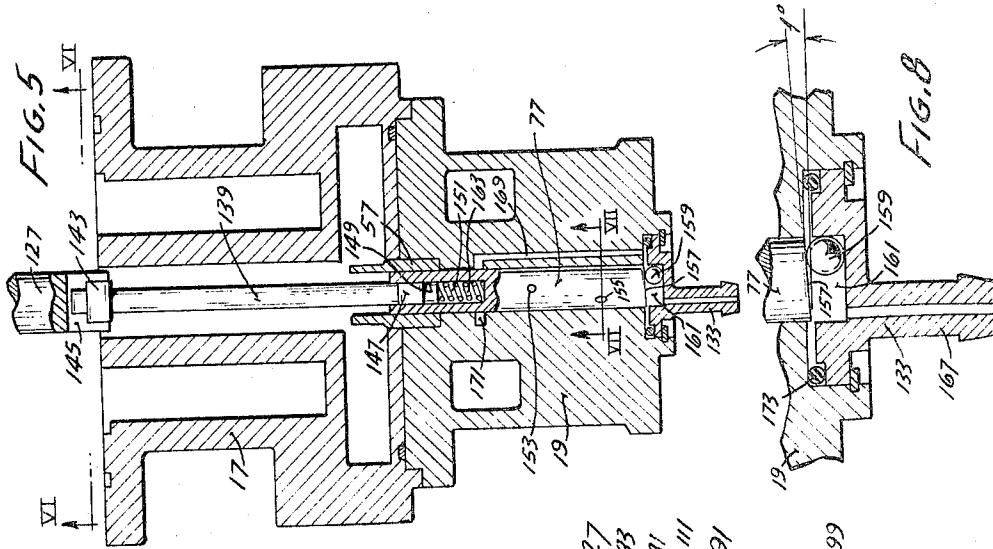
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INJECTION PUMP

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2 Sheets-Sheet 2



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3,277,828

INJECTION PUMP

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 20 Claims. (Cl. 103-2)

The invention relates generally to fuel injection pumps and particularly to fuel injection pumps for handling such low viscosity fuels as gasoline. More particularly, the invention also relates to fuel injection pumps for such engines which operate at relatively high crankshaft speeds, such as for instance, two-stroke engines operating at speeds of about five thousand r.p.m., and for multi-cylinder engines with an even number of four or more cylinders.

The invention has for one of its objects the provision of a fuel pump including a separate pumping unit for each pair of engine cylinders, means for effecting pumping operation of each unit twice during each complete engine cycle, i.e., twice for every crankshaft revolution when the fuel pump is used in connection with a two-stroke engine and once for every crankshaft revolution when the fuel pump is used in connection with a four-stroke engine, together with means for distributing the fuel pumped from each pumping unit alternately between each of the associated pair of engine cylinders.

In the illustrated preferred embodiment which is intended for use with a six-cylinder two-stroke engine, the fuel injection pump includes three pumping units which are arranged for pumping operation by a two-lobed cam rotating at engine speed. Each of the pumping units discharges into a conduit having two branches terminating in a bore in which a distributor is journaled for rotation at a speed equal to the rotation of the two-lobed cam. Also terminating in the bore are six fuel discharging passages which are respectively associated with each of the conduit branches. The distributor includes bores which, with respect to each pumping unit, alternately connect the respective branches of each conduit with their associated fuel discharging or distributing passages.

The invention also provides means for imparting limited axial reciprocation of the distributor relative to the bore to prevent the occurrence of scoring or the like in response to distributor rotation. Still further, the invention provides an arrangement for collecting and draining any fuel leakage occurring between the distributor and the bore. In addition, the invention provides for common adjustment in the rate of fuel delivered from the pumping units.

The illustrated construction operates well with gasoline and has the advantages of low cost, simple fuel rate adjustment, relatively compact size, and low fuel supply pressure. Other objects and advantages of the invention will become known by reference to the following description and accompanying drawings in which

FIGURE 1 is a partially schematic sectional view of one embodiment of a fuel pump in accordance with the invention;

FIGURE 2 is a sectional view taken along line 2-2 of FIGURE 1;

FIGURE 3 is a sectional view taken along line 3-3 of FIGURE 1;

FIGURE 4 is a sectional view taken along line 4-4 of FIGURE 1;

FIGURE 5 is a sectional view taken along line 5-5 of FIGURE 1 and 5-5 of FIGURE 4;

FIGURE 6 is a fragmentary view, partially in section, taken along line 6-6 of FIGURE 5;

FIGURE 7 is an enlarged, fragmentary sectional view taken along line 7-7 of FIGURE 5;

FIGURE 8 is an enlarged fragmentary view, in section, of a portion of the distributor shown in FIGURE 1; and

FIGURE 9 is an enlarged fragmentary view, partially in section, of a portion of the pump shown in FIGURE 1.

The fuel injection pump 11 comprises a supporting housing 13 including a first section 15 which includes connected first and second subsections 17 and 19 of cast aluminum and cast steel, respectively, which supports a series of fuel pumping units 21, and which includes an elongated centrally extending bore 22. Also included in the housing 13 is a second section 23 which rotatably supports a cam 25 operably engaging the pumping units 21. As the fuel injection pump is intended for use in connection with a six-cylinder engine, three pumping units 21 of generally identical construction are provided.

The pumping units 21 are arranged in generally parallel relation to each other at a common radial distance from the central bore 22 and in equi-angular relation to each other with respect to the bore 22. As the pumping units 21 are all identically mounted and constructed, only one of the pumping units 21 will be described.

Each pumping unit 21 is housed in a separate cavity 27 formed in the housing section 15 and includes a bushing 29 fixed against rotation in the cavity 27 by a pin 31. Axially and rotatably displaceable in the bushing 29 is a pumping plunger 33. Formed, at least in part, in one end of the bushing 29, is a pumping chamber 35 relative to which the plunger 33 is reciprocable to effect pumping operation. In this regard, the plunger 33 is normally maintained in a retracted position with respect to the pumping chamber by a spring 37 which is supported between a seat 39 mounted on the housing section 15 and a seat 41 provided in a crown 43 connected to the head 45 of the plunger 33. Rotatably supported by the crown 43 is a cam follower in the form of a roller 47 which is disposed in radial relation to the bore 22. Engagement of the roller 47 by the before-mentioned cam 25 effects reciprocation of the plunger 33 and consequent pumping operation.

Angular positioning of the plunger 33 relative to the bushing 29 controls the rate of fuel discharge by re-establishing communication between the pumping chamber 35 and a fuel well or sump 49 through a bypass arrangement 51 in response to plunger movement into the pumping chamber. More specifically, the plunger 33 has fixed thereto above the bushing 29 and below the spring 37 a gear segment 53 which is in mesh with a gear 55 journaled on a bearing 57 fixed in the central bore 22. Also in mesh with the gear 55 is another gear 59 which is carried on a stub shaft 61 journaled by the housing 13. Connected to the stub shaft 61 is an actuating arm 63 which can be controlled in any desired manner. Accordingly, angular shifting of the arm 63 results in common rotation or oscillation of the plungers 33 relative to their associated bushings 29 to obtain consequent control of the rate of fuel discharge. Detailed description of the construction and operation of the pumping units can be found in my copending application, Serial No. 208,286 and in chapter 12 of "Internal Combustion Engines" by Edward F. Obert, second edition, published by the International Textbook Company, Scranton, Pennsylvania.

Fuel is supplied to each of the pumping chambers 35 by means including the fuel sump or well 49 which comprises, in each of the cavities 27, an annular recess 65 in the cavity wall and a bore 67 which extends through the associated bushing 29 in communication with the associated pumping chamber and fuel well. Interconnecting each of the annular recesses 65 is a series of fuel passageways 69. Respectively communicating with each of the recesses 65 is a threaded bore 71 which can be fitted with either a fuel supply line or with a plug 73. The pro-

vision of three of the threaded bores 71 permits connection of the fuel supply line to one of the bores while the other two bores are closed off by plugs 73.

Fuel is conducted from each of the pumping chambers 35 to the various engine cylinders by means including a separate conduit system 75 associated with each of the pumping units 21 and a common distributor 77 rotatably carried in the central bore 22. More particularly, the pumping chambers 35 are all generally identical, each being formed, in part, by a sleeve 81 which includes a head 83 having a side face 85 in engagement with the wall of the associated cavity 27 and having an end face 87 in abutting engagement with the adjacent end of the associated bushing 29. Extending from the head 83 is a portion 89 of lesser diameter which includes one or more axially extending grooves 91 in its outer surface. Such grooves communicate with an annular passageway 93 which, in turn, communicates with the associated conduit system 75.

Press fitted centrally through the sleeve 81 is a cylindrical member 94 which includes a central aperture 95 which communicates with the associated pumping chamber 35 and which can be considered a fuel discharge port for the associated pumping unit. The sleeve 81 is retained in the associated cavity 27 and in abutting engagement with the adjacent bushing 29 by engagement of a hollow plug 97 which is threaded into a threaded end portion 99 of the cavity 27. The plug 97 provides a closed socket 101 constituting a seat for compressing a spring 103 urging a check valve element 105 against the adjacent end of the central aperture 95 in the member 94. During pumping operation, fuel flows through the central aperture 95 into the closed socket 101, through the grooves 91, and into the annular passageway 93.

Each of the conduit systems 75 is generally identical, each system communicating with one of the annular passageways 93. Each conduit system 75 includes a fuel line 111 which extends radially of the bore 22, communicating with the annular fuel passageway 93 and terminating in a conduit 113 extending in spaced parallel relation to the central bore 22. Extending from the conduit 113 are two legs or branches 115 and 117 which terminate in the central bore 22 in axially aligned but spaced relation to each other.

Terminating in diametrically opposed relation to the ends of the legs 115 and 117 are respective radially extending fuel-distributing passages 119 and 121 communicating with respective fittings 123 and 125 which, in turn, are connected to the fuel lines leading to the associated engine cylinders.

As the disclosed construction includes three of the pumping units 21, the overall arrangement includes three legs 115 which terminate at the central bore 22 in a common plane normal thereto and which are equiangularly spaced around the bore. In addition, three fuel-distributing passages 119 terminate at the central bore 22 in said plane and in respective diametrically opposed relation to the several legs 115. Still further, three conduit legs 117, as well as three fuel-distributing passages 121 terminate at the central bore 22 in like manner to the legs 115 and fuel-distributing passages 119 and in axially spaced relation thereto.

The conduit legs 115 and 117 are connected for the passage of fuel to the fuel-distributing passages 119 and 121 by the distributor 77 which is a cylindrical member rotatably carried in the central bore 22 and which is connected to the cam 25 for concurrent rotation. More particularly, the cam 25 is carried on the end of a shaft 127 which is rotatably journaled in the second housing section 23 in axial alignment with the central bore 22 and which is connected by suitable means to the engine for rotation at engine speed. As each of the pumping units 21 is utilized to supply fuel to two associated engine cylinders during each engine revolution, the cam is provided with means for actuating each pumping unit twice for each cam rotation. In this connection, the cam 25 includes two angularly spaced lobes or projections 129

and 131 which are adapted to cause plunger movement toward the pumping chambers 35. While various spacings can be used, the lobes are angularly spaced from each other by approximately 150 degrees. Consequently, a slug or quantity of fuel is discharged at angular intervals corresponding to 30; 120; 150; 240; 270; and 360 degrees of engine crankshaft rotation.

The distributor 77 extends in closely fitting engagement with the bore 22 from adjacent a closure in the form of a plug or cap 133 secured in an opening at the bottom of the central bore 22 by suitable means such as a snap ring 135, to within the bearing 57 about which the gear 55 is rotatable. Connecting the distributor 77 to the cam 25 to effect common rotation thereof is a connecting element or rod 139 having a head 141 with a pair of radially extending wings 143 which are received in a diametrically extending socket 145 at the end of the shaft 127. At its other end, the connecting rod 139 is connected to the distributor by means affording lost axial motion while providing positive rotary motion. Such means includes a pair of lugs 147 extending radially from the rod 139, which lugs 147 are received in diametrically extending slots 149 in the cylindrical wall of an axial socket 151 at the adjacent end of the distributor 77.

Communication between the respective legs and fuel-distributing passages is provided, in response to distributor rotation, by a pair of diametric bores 153 and 155, which bores are axially spaced corresponding to the spacing between the conduit legs 115 and 117. Although other angular relations can be used in connection with engines having firing sequences other than the intended sequence above noted, in the illustrated preferred embodiment, the diametric bores 153 and 155 are angularly offset by about thirty degrees, and are generally in angular registration with the lobes 129 and 131 on the cam 25. In addition, the ends of the bores 153 and 155 can be enlarged in a bell shape to facilitate free flow from the conduit legs to the fuel-distributing passages.

In order to prevent scoring of the fit between the distributor 77 and the central bore 22, means are provided for reciprocating the distributor through a limited range axially of the bore 22. In this connection, the end of the distributor seen at the bottom in FIGURE 6 is slightly bevelled as shown at 157 and rides on a ball bearing 159 which is freely received in a recess 161 formed in the plug 133. The distributor 77 is seated on the ball bearing 159 by a spring 163 which is located in the axial socket 151 in the distributor 77 and bears between the bottom of the socket 151 and the end of the connected rod 139. As a consequence, distributor rotation also serves to effect limited axial distributor reciprocation relative to the central bore 22.

Due to the tolerance required to permit assembly of the distributor in the bore and relative rotation therebetween, some minor degree of fuel leakage from the conduit systems 75 will generally occur between the distributor 77 and the wall of the central bore 22. The illustrated construction provides for collecting such leakage and returning it to the fuel source. More specifically, the end plug 133 includes a nipple 167 which communicates with the recess 161 and which is adapted to be connected with a conduit for returning fuel to the source. Extending within the housing subsection 19 in radially spaced, parallel relation to the central bore 22, as shown best in FIGURE 5, is a passage 169 which communicates with an annular groove 171 in the wall of the central bore 22 at a point located above the upper diametrical bore 153 and below the bearing 57. At its lower end, the passage 169 communicates with the recess 161 in the plug 133.

The groove 171 serves as a collector for any fuel leaking upwardly along the distributor 77, which fuel is drained through the passage 169 into the recess 161.

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Fuel which leaks downwardly along the distributor 77 collects in the recess 161 and, with the fuel arriving through the passage 169, is drained through the nipple 167 to the fuel source. A suitable O-ring 173 is located between the plug 133 and the housing 13 to prevent fuel leakage therebetween.

Various of the features of the invention are set forth in the following claims.

What is claimed is:

1. A fuel injection pump comprising a housing including a series of fuel pumping units each having a fuel discharge port, means engaged with said pumping units for effecting fuel pumping operation thereof, separate conduit means communicating with each of said fuel discharge ports, each of said separate conduit means including first and second branch conduits, separate fuel-distributing passages respectively associated with each of said branch conduits, and means for alternately connecting, simultaneously with respect to each operation of the respective pumping units, said first branch conduit with the respectively associated one of said fuel-distributing passages and said second branch conduit with the respectively associated one of said fuel-distributing passages.

2. A pump in accordance with claim 1 wherein said pumping units are arranged in equi-angular relation to one another at a common radial distance from the central axis, and said means for operating said pumping units comprises a two-lobed cam rotatable about said axis.

3. A fuel injection pump according to claim 2 wherein said pumping units each include a pumping chamber of variable volume, a plunger, and means supporting said plunger for reciprocation relative to said pumping chamber to effect fuel pumping operation, each of said plungers being engaged by said cam, and means for supplying fuel to said pumping chambers.

4. A fuel injection pump according to claim 3 and including means connected with each of said pumping units for common control of the quantity of fuel pumped in response to each reciprocation of said plungers.

5. A pump in accordance with claim 2 wherein said housing includes means defining a cylindrical bore concentric with said axis, and said conduit and fuel-distributing passage connecting means includes a cylindrical distributor in said bore, and means connecting said distributor with said cam for rotation thereof at the same speed.

6. A pump in accordance with claim 1 wherein said means for alternately connecting said branch conduits and the respectively associated fuel-distributing passages comprises means defining a cylinder in said housing and a distributor rotatably carried in said cylinder and including at least one transverse bore for respectively connecting said first and second branch conduits with the respectively associated fuel-distributing passages in response to rotation of said distributor.

7. A fuel injection pump according to claim 3 and including means connected with each of said pumping units for rotating said plungers to afford common control of the quantity of fuel pumped in response to each reciprocation of said plungers.

8. A fuel injection pump comprising a housing including a series of fuel pumping units each having a fuel discharge port, said housing also including means defining a cylindrical bore, means engaged with said pumping units for effecting fuel pumping operation of said pumping units, separate conduit means communicating with each of said fuel discharge ports and including first and second branch conduits, separate fuel distributing passages respectively associated with each of said branch conduits, means including a cylindrical distributor in said bore operating simultaneously with respect to each operation of the respective pumping units, for alternately connecting said first branch conduit with the respectively associated one of said fuel distributing passages and said

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second branch conduit with the respectively associated one of said fuel distributing passages, and means for reciprocating said distributor for a limited axial distance incident to rotation thereof.

9. A pump in accordance with claim 8 wherein said means for effecting fuel pumping operation includes a rotatable cam, wherein said means for alternately connecting the branch conduits with the respectively associated distributing passages includes means connecting said distributor and said cam for rotating the distributor at the same speed as said cam, and said means connecting said distributor and said cam includes means affording lost motion in a direction axially of said distributor.

10. A pump in accordance with claim 8 wherein said distributor reciprocating means includes a ball bearing, means supporting said ball bearing adjacent to one end of said bore, means defining a beveled surface on the end of said distributor adjacent to said one end of said bore, and spring means resiliently seating said distributor on said ball bearing.

11. A fuel injection pump comprising a housing including a series of fuel pumping units each having a fuel discharge port, said housing also including means defining a cylinder, means engaged with said pumping units for effecting fuel pumping operation of said pumping units, separate conduit means communicating with each of said fuel discharge ports and including first and second branch conduits, separate fuel distributing passages respectively associated with each of said branch conduits, means including a cylindrical distributor in said cylinder operating simultaneously with respect to each operation of the respective pumping units, for alternately connecting said first branch conduit with the respectively associated one of said fuel distributing passages and said second branch conduit with the respectively associated one of said fuel distributing passages, said distributor including at least one transverse bore for establishing communication between said branch conduits and said fuel distributing passages, means defining a closure at one end of said cylinder, said closure including a recess having means affording drainage therefrom, an annular groove in the wall of said cylinder spaced from said one end thereof beyond all of said transverse bores, and passage means in said housing connecting said groove and said recess whereby any leakage of fuel occurring between said distributor and said cylinder is collected in said recess for drainage.

12. A pump in accordance with claim 11 including means defining a beveled surface at the end of said distributor adjacent to said one end of said cylinder, a ball bearing carried in said recess, said recess being proportioned to maintain said ball bearing in position for engagement with said end of said distributor, and means for resiliently seating said distributor on said ball bearing.

13. A fuel injection pump comprising a housing including a series of fuel pumping units each having a fuel discharge port, said housing also including means defining a cylinder, means engaged with said pumping units, separate conduit means communicating with each of said fuel discharge ports and including first and second branch conduits, separate fuel distributing passages respectively associated with each of said branch conduits, means including a cylindrical distributor in said cylinder operating in coordination with each operation of the respective pumping units, for alternately connecting said first branch conduit with the respectively associated one of said fuel distributing passages and said second branch conduit with the respectively associated one of said fuel distributing passages, said distributor including at least one transverse bore for respectively connecting said first and second branch conduits with the respectively associated fuel distributing passages in response to distributor rotation, and means for reciprocating said distributor for a limited axial distance incident to rotation thereof.

14. A pump in accordance with claim 13 wherein said distributor reciprocating means includes a ball bearing,

means supporting said ball bearing adjacent to one end of said cylinder, means defining a beveled surface on the end of said distributor adjacent to said one end of said cylinder, and spring means resiliently seating said beveled surface of said distributor on said ball bearing.

15. A fuel injection pump comprising a housing having a cylindrical bore and a series of fuel pumping units each having a fuel discharge port, means engaged with said pumping units for effecting fuel pumping operation thereof, separate conduit means communicating respectively with each of said fuel discharge ports, each of said conduit means including a first and a second branch conduit, said first branch conduits terminating in said bore in equi-angular relation to each other in a first plane normal to the axis of said bore, said second branch conduits terminating in said bore in equi-angular relation to each other in a second plane in spaced relation to said first plane, a first group of fuel-distributing passages equal in number to the number of pumping units, said passages in said first group being respectively associated with said first branch conduits and terminating in equi-angular relation to each other in said bore in a third plane normal to the axis of said bore, a second group of fuel-distributing passages equal in number to the number of pumping units, said passages in said second group being respectively associated with said second branch conduits and terminating in equi-angular relation to each other in said bore in a fourth plane in spaced parallel relation to said third plane, a cylindrical distributor rotatably carried in said bore, means for rotating said distributor, means in said distributor defining a first and second transverse bore in axially and radially angularly spaced relation to each other, said first transverse bore having one end terminating in said first plane and having its other end terminating in said third plane and disposed for respective communication with said fuel-distributing passages of said first group when said one end thereof is in communication with the respectively associated first branch conduits, and said second transverse bore having one end terminating in said second plane and having its other end terminating in said fourth plane and disposed for respective communication with said fuel-distributing passages in said second group when said one end thereof is in communication with the respectively associated second branch conduits.

16. A fuel injection pump comprising a housing having a cylindrical bore and a series of fuel pumping units each having a fuel discharge port, means engaged with said pumping units for effecting fuel pumping operation thereof, separate conduit means communicating respectively with each of said fuel discharge ports, each of said conduit means including a first and a second branch conduit, said first branch conduits terminating in said bore in equi-angular relation to each other in a first plane normal to the axis of said bore, said second branch conduits terminating in said bore in equi-angular relation to each other in a second plane in spaced relation to said first plane, a first group of fuel-distributing passages equal in number to the number of said first branch conduits respectively associated therewith and terminating in said bore in said first plane in diametrically opposed relation to said respectively associated first branch conduits, a second group of fuel-distributing passages equal in number to the number of said second branch conduits respectively associated therewith and terminating in said bore in said second plane in diametrically opposed relation to said respectively associated second branch conduits, a cylindrical distributor rotatably carried in said bore, means for rotating said distributor, means in said distributor defining a first and second diametric bore

in axially and radially angularly spaced relation to each other, said first diametric bore being located in said first plane, and said second diametric bore being located in said second plane.

17. A pump in accordance with claim 16 wherein said pumping units are arranged in equi-angular relation to one another at a common radial distance from a central axis, and said means for operating said pumping units comprise a two-lobed cam rotatable about said axis, said cams being spaced from each other at an angle corresponding to the angular spacing of said diametric bores in said distributor.

18. A fuel injection pump including a housing including means defining a cylindrical bore, means defining a fuel supply conduit and a fuel distributing passage communicating with said bore at points spaced from one end thereof, and means defining an annular groove in the wall of said cylindrical bore at a point spaced from said one end of said bore beyond the point of communication of said conduit and said passage with said bore, a cylindrical distributor journaled in said bore for rotation, said distributor including a bore therein for establishing communication between said fuel supply conduit and said fuel distributing passage in response to rotation of said distributor, means connected to said housing for closing said one end of said bore and including means defining a recess adjacent to said one end of said bore, said recess having means affording drainage thereof, and means in said housing and in said bore closing means for affording communication between said groove and said recess.

19. A pump in accordance with claim 18 wherein the end of said distributor adjacent to said one end of said bore is bevelled and includes a ball bearing carried in said recess, said recess being proportioned to maintain said ball bearing in position for engagement with said bevelled end of said distributor, and spring means resiliently seating said bevelled end of said distributor on said ball bearing.

20. A fuel injection pump comprising a housing including a series of fuel pumping units each having a fuel discharge port, said housing also including means defining a cylinder, means engaged with said pumping units for effecting fuel pumping operation of said pumping units, separate conduit means communicating with each of said fuel discharge ports and including first and second branch conduits, separate fuel distributing passages respectively associated with each of said branch conduits, and means including a cylindrical distributor in said cylinder for operating in coordination with each operation of the respective pumping units, for alternately connecting said first branch conduit with the respectively associated one of said fuel distributing passages and said second branch conduit with the respectively associated one of said fuel distributing passages, said distributor including two separate bores spaced axially of said distributor for respectively connecting said first and second branch conduits with the respectively associated fuel distributing passages in response to distributor rotation.

References Cited by the Examiner

UNITED STATES PATENTS

2,445,266	7/1948	High	-----	123—139.11
2,447,423	8/1948	Nies	-----	123—139.11
2,969,738	1/1961	Ulbing	-----	103—41.2

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