July 18, 1967 V. D. ROOSA 3,331,327

FUEL PUMP

Filed Dec. 9, 1965

3 Sheets-Sheet 1

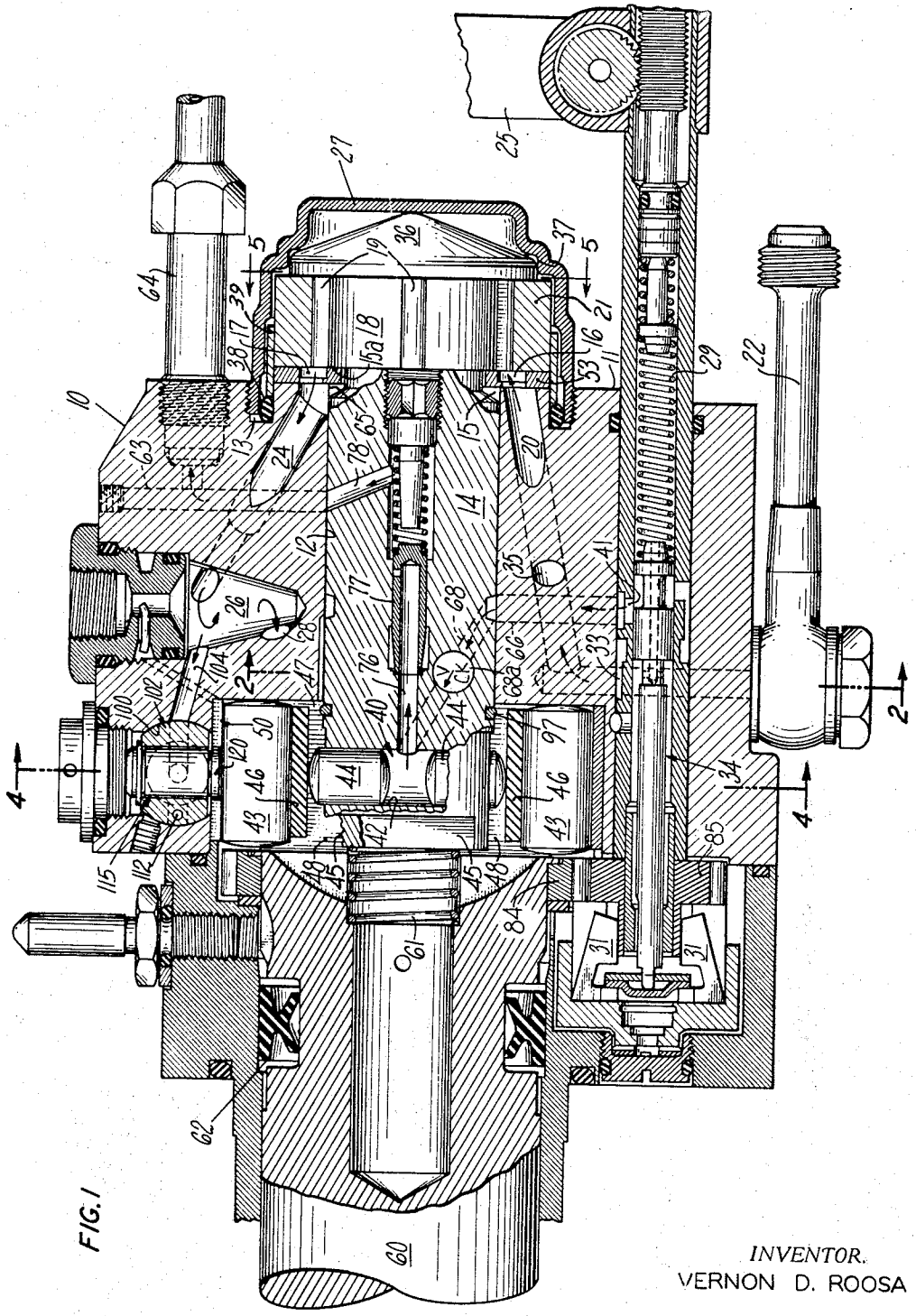


FIG. 1

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FIG. 2

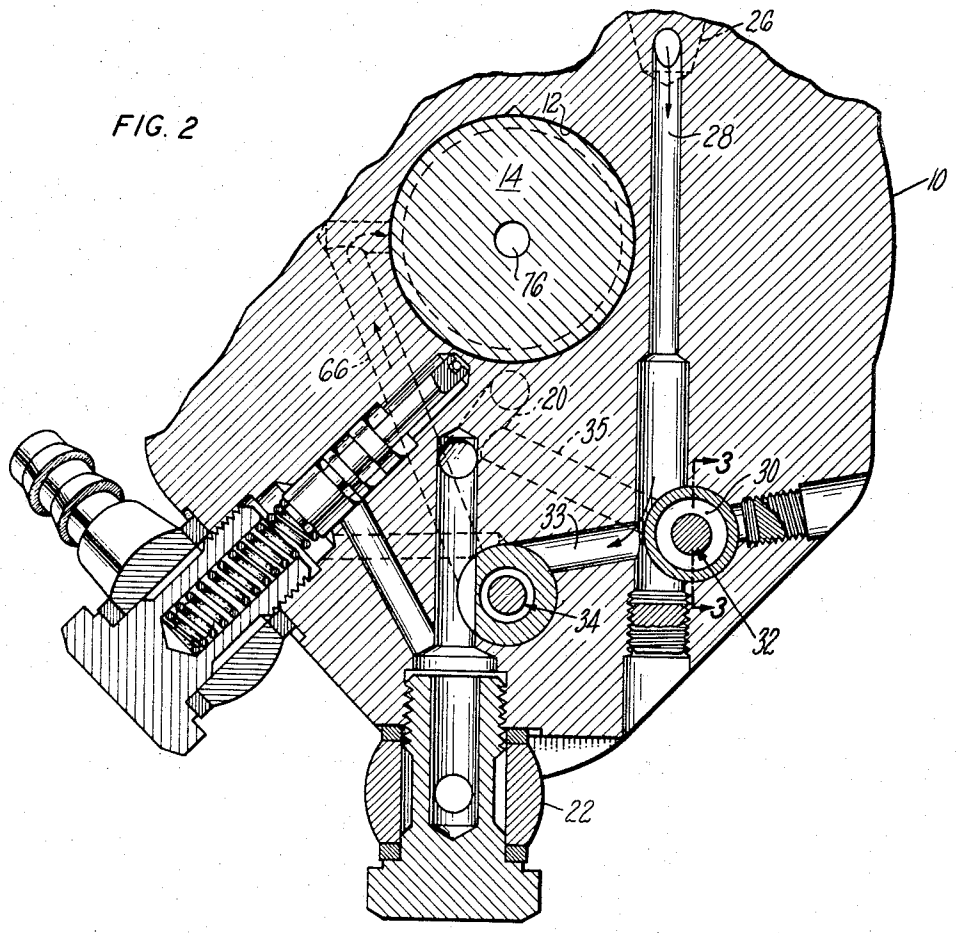
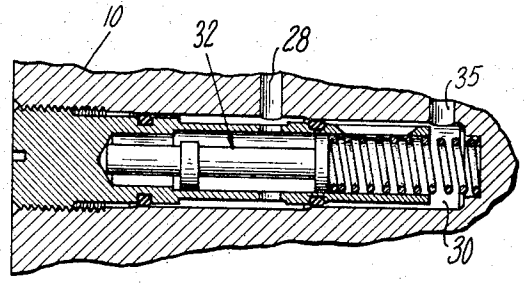


FIG. 3



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FIG. 4

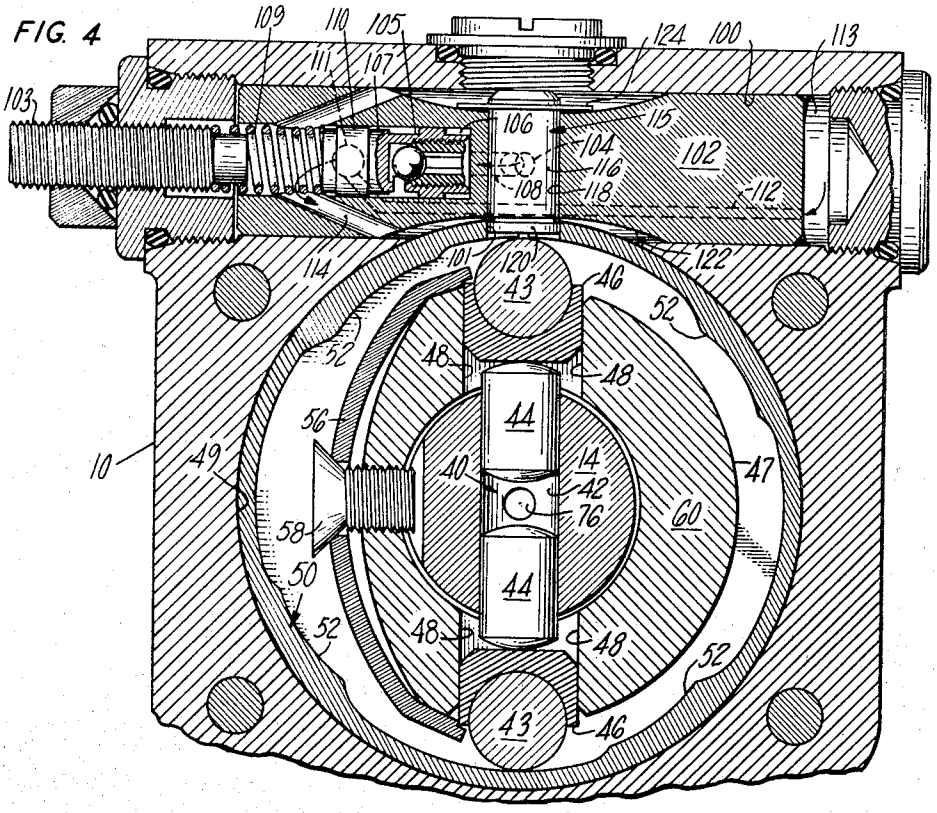


FIG. 5

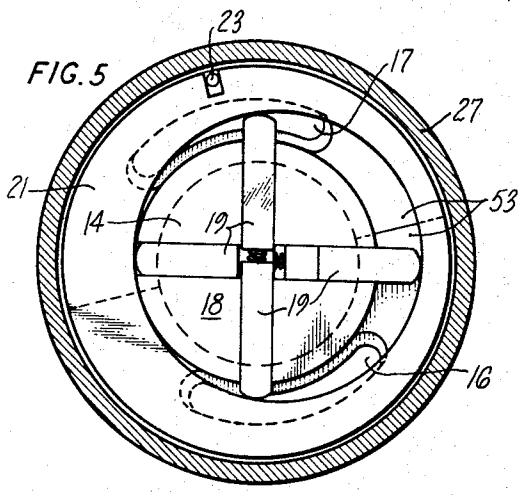
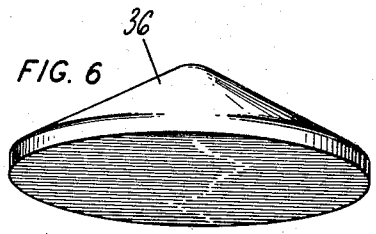


FIG. 6



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3,331,327

FUEL PUMP

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7 Claims. (Cl. 103—5)

The present invention relates to fuel pumps of the type utilized in fuel injection systems for delivering measured charges of fuel to the nozzles of an internal combustion engine.

A principal aim of this invention is to provide an improved fuel pump of the type referred to which is particularly suited for ease of manufacture and assembly.

A further object of this invention is to provide a distributor type pump of a design which minimizes wear during use. Included in this object is the provision of means to equalize the axial forces acting on the distributor rotor and to guard against wear resulting from differential expansion of the rotor and the pump housing.

Other objects will be in part obvious and in part pointed out more in detail hereinafter.

The invention accordingly consists in the features of construction, combination of elements and arrangement of parts which will be exemplified in the construction hereafter set forth, and the scope of the application of which will be indicated in the appended claims.

In the drawings:

FIG. 1 is a longitudinal cross-sectional view, partly broken away, of a fuel injection pump embodying the present invention;

FIG. 2 is an enlarged fragmentary sectional view taken along the line 2—2 of FIG. 1;

FIG. 3 is a fragmentary sectional view along the line 3—3 of FIG. 2;

FIG. 4 is an enlarged cross-sectional view taken along the line 4—4 of FIG. 1;

FIG. 5 is a cross-sectional view taken along line 5—5 of FIG. 1; and

FIG. 6 is a perspective view of the end plate of FIG. 5.

Referring now to the drawings in detail, in which like numerals refer to like parts throughout the several figures, a pump exemplifying the present invention is of the type now commercially available for supplying fuel charges to an associated internal combustion engine. The pump comprises an external housing or casing **10** having an axial bore or opening **12** rotatably supporting a pump rotor or distributor **14**.

At the right end of housing **10**, as viewed in FIG. 1, there is mounted a vane-type fuel supply or transfer pump **18** driven by the rotor **14** and having an inlet port **16** and a discharge port **17**. A diagonal inlet passage **20** delivers fuel to the transfer pump **18** from an inlet pipe **22** which is connected to a fuel supply reservoir. The transfer pump delivers fuel under pressure through an outlet passage **24** in the housing **10** to an air separator **26** from whence the fuel flows through a passage **28** (FIG. 2) in the housing **10** to a longitudinal bore **30** in the housing. A slideable spring biased pressure regulating valve **32** (FIG. 3) is mounted in the bore **30** for regulating the output pressure of the pump **18**. Regulating valve **32** delivers fuel to the rotating metering valve **34** at a pressure correlated with the speed of the driving engine through conduit **33** and returns excess fuel to the transfer pump inlet conduit **20** through conduit **35**.

The high pressure charge pump generally denoted by the numeral **40** is formed by a transverse bore **42** in rotor **14** in which are slideably mounted a pair of opposed plungers **44**. The outer ends of the plungers engage against shoes **46** which are slideably mounted in transverse passages **48** formed by the bifurcated end **47** of a

separable drive shaft **60** aligned with bore **42**. As shown in FIG. 4, the bifurcated end of drive shaft **60** also provides a pair of flat opposed shoulders which engage complementary shoulders **45** on the rotor **14** to drive the same.

Surrounding the rotary member **14** is a generally circular or ring-like cam ring **50** preferably constructed of hardened steel which encircles the rotor **14** in the plane of revolution of the plungers **44** and is mounted for angular adjustment within an annular bore **49** in the pump housing. The cam has a plurality of pairs of diametrically opposed inwardly extending cam lobes **52** which are adapted to actuate the plungers **44** inwardly simultaneously for discharging fuel from the pump, it being understood that the rollers **43** and the roller shoes **46** are disposed between the plungers **44** and the cam **50** whereby the rollers **43** act as cam followers for translating the cam contour into this reciprocal movement of the plungers **44**. The C-shape ring **56** secured to the charge pump by a screw fastener **58** (FIG. 4) provides an adjustable outer resilient top for the roll shoes **46**. A seal **62** is provided to prevent leakage of fuel into or out of between the shaft **60** and the housing **10**.

Upon rotation of the drive shaft **60**, the transfer pump **18** and the charge pump **40** are rotated to supply measured charges of fuel under pressure to a plurality of fuel pump outlets **64** having suitable connections with the fuel injection nozzles of an associated engine. During the outward or intake stroke of the plungers **44** fuel is delivered to the charge pump from the metering port **41** by a passage **66** in the housing **10** and a diagonal passage **68** in the rotor **14**. During the inward or discharge stroke of the plungers **44** fuel is delivered under high pressure by an axial passage **76** to a pressure-operated delivery valve **77** and a generally radially extending distributor passage **78** for sequential registration with a plurality of angularly spaced radial delivery passages **63** in fluid communication respectively with a plurality of pump outlets **64** (only one of which is shown for convenience of illustration). It is to be noted that a one-way check valve **68***a* prevents reverse flow through inlet passage **68** during the discharge stroke of charge pump **40**.

The metering valve **34** may be adjusted in any suitable manner, and in the illustrated embodiment is shown as being a spool valve axially adjustable and rotatably driven by the centrifugal governor **31** against the force of spring **29**, the bias of which may be adjusted or varied by lever **25**. The governor **31** is provided with a gear **85** driven by gear **84** secured to shaft **60**. Inasmuch as the axial force of centrifugal governor **31** is a function of engine speed, the position of the metering valve **34** and hence the restriction offered by the metering port **41** due to the axial shifting of the spool **34** will govern the engine at a speed which may be selected by varying the bias of the compression spring **29**.

Referring now specifically to FIG. 4, there is shown a transverse bore **100** in the housing **10** in which an axially movable plunger **102** is reciprocably mounted. A passage **104** (FIG. 1) from the air separator **26** is shown as being in communication with the bore **100** to deliver regulated transfer pump outlet pressure thereto. In the illustrated design, the plunger **102** includes a pilot valve **105** positioned in a chamber **106**, one end of which continuously communicates with housing passage **104** through passage **108** in plunger **102**. A one-way valve is positioned in pilot valve **105** to prevent the reverse flow of fluid through the passage **108** as a result of pulsations of force imposed on the plunger **102** due to the operation of the charge pump.

Pilot valve **105** is provided with an adjustable biasing spring **109** which engages the end of a threaded adjusting screw **103** at the end of transverse housing bore **100**. Spring **109** opposes the transfer pump outlet pressure

acting on the right end of the pilot valve with the result that transfer pump output pressure will urge the plunger 102 to the left, as seen in FIG. 2, against the bias of compression spring 109.

Pilot valve 105 is also provided with an annular land 110 which is axially shiftable over port 111 in the plunger 102. Port 111 communicates through passage 112 to a chamber 113 formed in the end of transverse housing bore 100 to deliver fuel under pressure thereto when annular land 110 of the pilot valve is moved to the left to provide communication between passage 106 and port 111 via annulus 107 and passage 112. Inasmuch as the transfer pump pressure is a function of engine speed, the balanced position assumed by the pilot valve is determined by equilibrium between the forces imposed thereon by the transfer pump pressure and spring. This, in turn, determines whether the port 111 communicates with annulus 112 to receive additional fuel from the transfer pump (and hence shift plunger 102 to the left to advance the time of injection) or the port 111 communicates with passage 114 to dump a portion of the fuel trapped in the chamber 113 into the pump housing through passage 114 to permit the plunger 102 to move to the right. As shown in FIG. 4, the left end of annulus 107 is of reduced cross section to throttle the flow of fuel therethrough and stabilize the operation of the pilot valve.

Since one end of the spring 109 engages stationary screw 103, it will be apparent that when the pilot valve is in equilibrium, the port 111 will be automatically closed by land 110 as the plunger 102 moves to the left by the increased fuel entering chamber 113.

For operatively connecting plunger 102 and cam 50, there is provided a connector 115 having a cylindrical body 116 mounted in a complementary radial bore 118 in the plunger 102. The connector 115 has an integral head 120 closely received within a bore 101 of the cam ring 50 which serves as a socket therefor. The plunger 102 is recessed at 122 to receive a portion of the cam ring 50 extending within the bore 100, and the connector 115 is preferably dimensioned to reciprocate with the plunger 102 within the peripheral confines of the bore 100. A snap ring 124 seated in an annular groove in the connector 115 prevents excess axial movement of the connector toward the cam ring.

In accordance with this invention, the rotor 14 extends beyond the end wall 11 of housing 10 and is slotted as indicated in FIG. 5 to receive spring biased segmented pumping vanes 19. Surrunding the transfer pump 18 is eccentric liner 21 which is held in a fixed position by suitable means such as pin 23.

The rotor 14 is provided with an annular groove 15 in which a seal ring member 53 is positioned. The seal ring member is also disposed between the eccentric liner 21 and housing end wall 11 and between the radial end wall 15*a* of the groove 15 and end wall 11 of the housing to isolate the inlet and outlet ports 16 and 17 of the pump 18. As shown in FIG. 5, the seal ring member 53 is formed of two semicircular elements so that it may be installed in the groove 15. As shown in FIG. 1, the seal ring member 53 does not completely fill the annular groove 15. Since the groove 15 communicates with the outlet passage 17 of pump 18 through port 65, it is filled with output fuel from the pump for purposes hereinafter more fully described.

In order to enclose the transfer pump 18, a cup-shaped cap member 27 is provided. The cap member surrounds transfer pump 18 and threadedly engages mating threads in annular recess 13 in housing end wall 11. An end plate 36 which is best shown in FIG. 6 is disposed within the cup-shaped member 27 at the end of the transfer pump 18. End plate 36 is provided with a conical surface terminating in an apex which engages the end wall of the cap 27 and a flat surface which engages the ends of eccentric liner 21, rotor 14 and vanes 19. The end cap is further provided with an annular shoulder 37 to locate

the end plate 36 concentrically with the end of the rotor 14. A seal ring 38 is provided to seal the end cap 27 to the housing 10. With such an arrangement, the end plate 36 will automatically align itself with the end of the transfer pump to accommodate any manufacturing variations or tolerances.

Another feature of this invention is the provision of an annular rim 39 which is dimensioned to slideably engage the inner wall of the recess 13 and surround the seal ring member 53 and the eccentric liner 21 to position and maintain these parts in alignment. This arrangement greatly facilitates the assembly and simplifies the manufacture of the pump.

As hereinbefore described, the drive shaft 60 is formed separately of rotor 14 and drives the same through the engagement of their cooperating shoulders 43, 45 respectively. A coil spring 61 is inserted in an annular cavity in the shaft to bias the rotor 14 toward the right as viewed in FIG. 1 and to minimize relative axial movement between the shaft 60 and the rotor 14. A snap ring 97 limits the movement of the rotor 14 to the right when cap 27 is removed.

In operation, as the rotor 14 is rotating, the transfer pump 18 will build up an output pressure at its outlet port 17 which pressure is correlated with rotor speed. As will be understood, the pump 18 will also build up a pressure between the upper portion of the rotor 14 and the end plate 36 to produce an axial thrust tending to urge the rotor 14 to the left.

According to another aspect of this invention, the spring force of spring 61 is selected to that at the normal operating speed of the pump of the rotor, the hydraulic pressure urging the rotor 14 to the left will be equal to the bias of spring 61 thereby to neutralize the axial thrust in the rotor and minimize the axial wear of the transfer pump 18.

It is also significant to the present invention that the annular groove 15 communicates through port 65 with the outlet of the transfer pump 18. With this construction, the annular groove 15 will be filled with pressurized output fuel delivered by the transfer pump to provide cooling and lubrication to the end of rotor 14 adjacent transfer pump 18. It will be therefore apparent that this invention minimizes the differential expansion and possibility of seizing of the rotor 14 within the bore 12. It will be apparent that during each rotation of rotor 14, all the fuel in groove 15 will pass the port 65 and intermix with the pressurized fuel flowing from the transfer pump 18 to maintain the fuel at a cool temperature.

From the foregoing it will be apparent that the improved transfer pump construction of this invention simplifies the manufacture of the pump by mounting the transfer pump on an extension of the rotor outside of the pump housing and enclosing the end thereof by a self-aligning end member. This, coupled with the other feature of the design provides a quality construction which will tolerate manufacturing deviations in the manufacture of the fuel pump with the economies resulting therefrom.

As will be apparent to person skilled in the art, various modifications and adaptations of the structure above described become readily apparent without departure from the spirit and scope of the invention, the scope of which is defined in the appended claims.

I claim:

1. In a fuel pump comprising a casing having inlet and outlet passages, a bore in said casing, a fuel distributing rotor positioned in said bore and having fuel inlet port means adapted to communicate with said inlet passage and having outlet port means adapted to communicate in sequence during the rotation of said rotor with the outlet passages of said casing to permit alternate admission and discharge of fuel from the interior of said rotor, a transfer pump positioned at one end of said rotor, said transfer pump comprising a hub portion mounted

to rotate with said rotor and having at least one transverse slot therein, a pumping vane positioned in said transverse slot, and an eccentric cam surrounding said hub portion, the improvement wherein an axially adjustable annular cup encloses said transfer pump and pivotally mounts an end plate to hold the same in alignment with the end of said cam.

2. In a fuel pump comprising a casing having inlet and outlet passages, a bore in said casing, a fuel distributing rotor positioned in said bore and having fuel inlet port means adapted to communicate with said inlet passage and having outlet port means adapted to communicate in sequence during the rotation of said rotor with the outlet passages of said casing to permit alternate admission and discharge of fuel from the interior of said rotor, a transfer pump positioned at one end of said rotor, said transfer pump comprising a hub portion mounted to rotate with said rotor and having at least one transverse slot therein, a pumping vane positioned in said transverse slot, and an eccentric cam surrounding said hub portion, the improvement wherein a ring member surrounds the annular cam and a mating shoulder on the end of the housing, and an axially movable cup member encloses said transfer pump and pivotally mounts an end plate to hold the same against the end of said cam.

3. A fuel pump comprising a casing having inlet and outlet passages, a bore in said casing, a fuel distributing rotor positioned in said bore and having fuel inlet port means adapted to communicate with said inlet passage and outlet port means adapted to communicate in sequence during the rotation of the rotor with the outlet passages of said casing to alternately admit and discharge fuel from the interior of the rotor, a wall at one end of said casing, a vane-type transfer pump surrounded by an eccentric cam positioned at said one end of said casing externally of said bore, a ring member surrounding said annular cam and engaging a shoulder on said wall to position and mount said annular cam in a radial direction and a removable cup member surrounding said ring member and secured to said wall, said cup member pivotally mounting an end plate to hold the same against the end of said cam.

4. A fuel pump comprising a casing having inlet and outlet passages, a bore in said casing, a fuel distributing rotor positioned in said bore and having fuel inlet port means adapted to communicate with said inlet passage and outlet port means adapted to communicate in sequence during the rotation of the rotor with the outlet passages of said casing to alternately admit and discharge fuel from the interior of the rotor, a wall at one end of said casing, a vane-type transfer pump surrounded by an eccentric cam positioned at said one end of said casing externally of said bore, an axially movable cup member

enclosing said transfer pump and pivotally mounting an end plate disposed within said cup to hold the same tightly against the end of said cam, said rotor having an annular groove substantially in radial alignment with said end wall, an annular sealing member positioned in said groove and between said end wall and said cam member and providing inlet and outlet ports for said transfer pump, and means providing communication between the outlet of said transfer pump and said annular groove to deliver output fuel from said pump to said groove.

5. A fuel pump comprising a casing having inlet and outlet passages, a bore in said casing, a fuel distributing rotor positioned in said bore and having fuel inlet port means adapted to communicate with said inlet passage and outlet port means adapted to communicate in sequence during the rotation of the rotor with the outlet passages of said casing to alternately admit and discharge fuel from the interior of the rotor, a wall at one end of said casing, a vane-type transfer pump surrounded by an eccentric cam positioned at said one end of said rotor externally of said casing, a ring member surrounding said annular cam and extending into an annular recess in said wall to position and mount said annular cam in a radial direction, and a cup member surrounding said ring member and threadedly engaged in said recess, said cup member pivotally mounting an end plate to hold the same against the end of said cam, a separable drive shaft drivingly coupled to the other end of said rotor, and spring means interposed between said drive shaft and said other end of said rotor for biasing said rotor toward said end plate.

6. A fuel pump as recited in claim 5 wherein the hydraulic output pressure between said end plate and said transfer pump increases to an amount at least equal to the biasing force of the spring within the operating speed range of the pump.

7. A fuel pump as recited in claim 5 wherein a stop means is provided on said rotor to engage with a shoulder of said housing to limit the axial movement of the rotor in the direction of said transfer pump.

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