June 2, 1953 A. M. BABITCH 2,640,424

FUEL PUMP

Filed Jan. 10, 1948 2 Sheets-Sheet 1

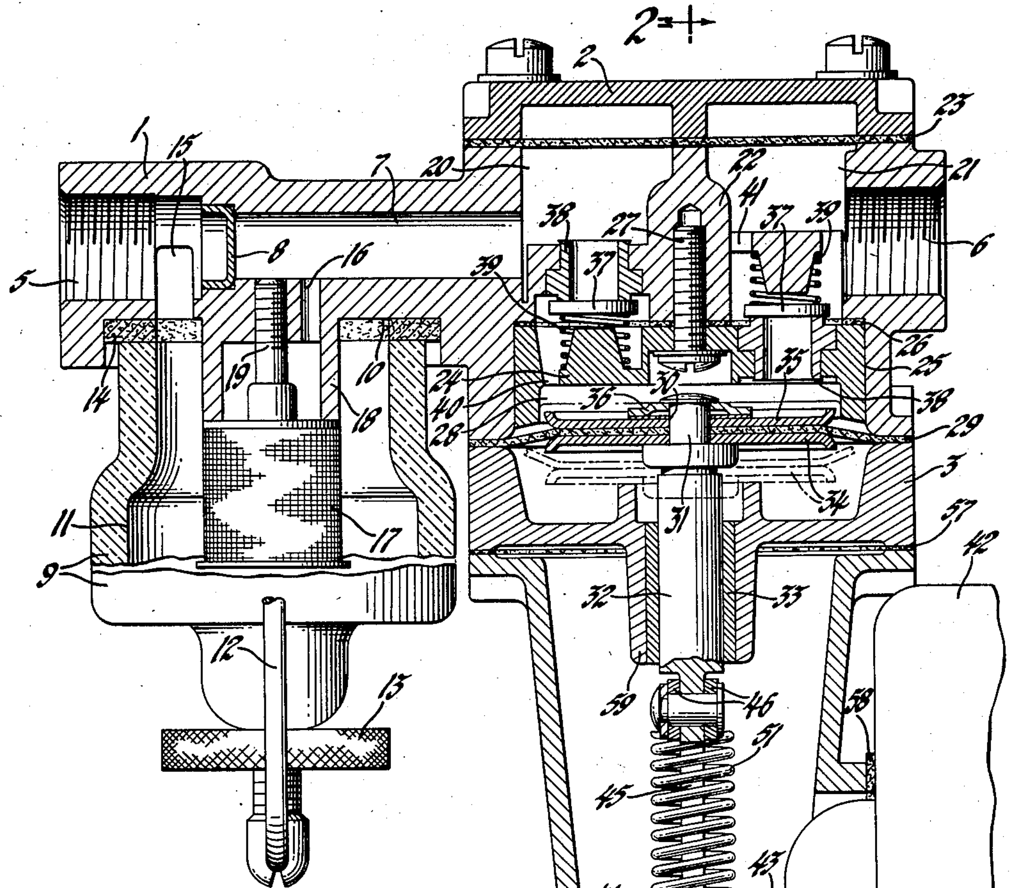

Fig. 1

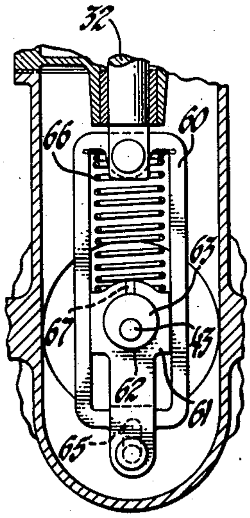

Fig. 5

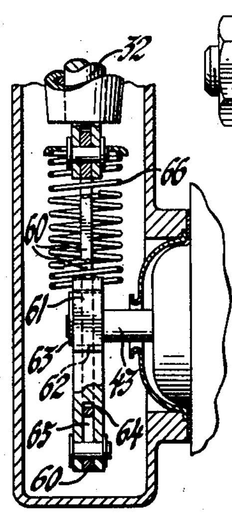

Fig. 6

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FUEL PUMP

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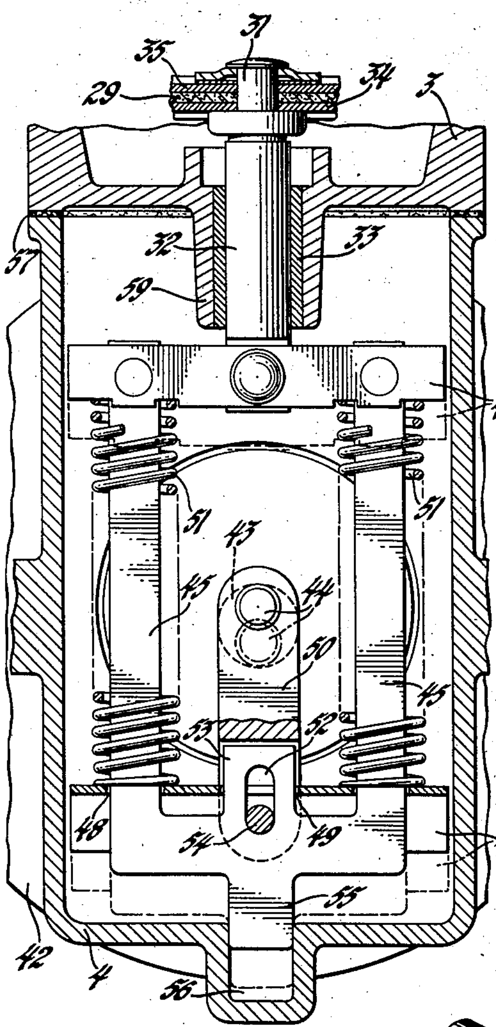


Fig. 2

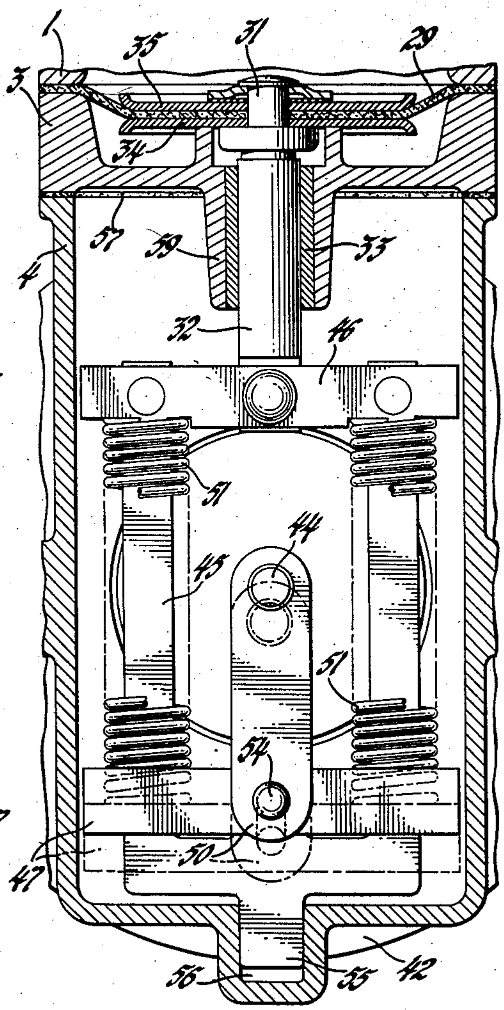
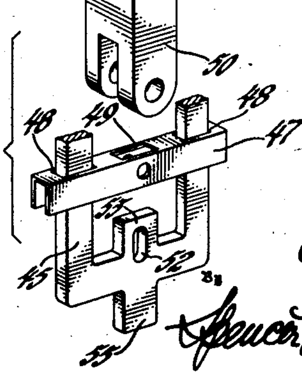


Fig. 3

Fig. 4



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FUEL PUMP

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16 Claims. (Cl. 103—38)

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The present invention relates to pumps and more particularly to operating mechanisms for pumps of the diaphragm type.

Diaphragm pumps are used extensively in automotive vehicles for transferring fuel from a reservoir to the engine. Such pumps usually employ an operating mechanism adapted to actuate the diaphragm against a biasing spring during the suction stroke and utilize the biasing spring to actuate the diaphragm during the discharge stroke. A mechanism commonly employed in cooperation with such a biasing spring comprises a lever which is continuously held in contact with a driving cam within the engine casing and some form of linkage between the diaphragm and lever which permits the diaphragm to have a variable discharge stroke in accordance with the pressure in the fuel delivery line. As the power required to actuate this type of mechanism varies considerably over a complete cycle of diaphragm movement due to the action of the biasing spring in resisting the suction stroke and assisting the discharge stroke such a mechanism is not particularly suitable to operation by small motors adapted to function in the low voltage electrical system of an automotive vehicle. In these instances where it is desirable to actuate the pumps by an electrical motor adapted to function in the low voltage circuit of an automotive vehicle, as for example, in locating the fuel pump at a point remote from the engine, a diaphragm actuating mechanism is preferred where the force required to actuate the diaphragm under conditions where there is very little or no pressure in the pumping chamber, is about equal for both the suction and discharge strokes and limited to the force required to overcome the friction in the moving parts of the mechanism.

It is therefore an object of this invention to provide a fuel pump with an actuating mechanism adapted to operation by a lightweight, low starting torque motor capable of functioning in the low voltage electrical system of an automotive vehicle.

It is another object of this invention to provide a fuel pump with an oil reservoir which will insure adequate lubrication of the moving parts of the actuating mechanism.

These and other objects are attained in accordance with one form of the invention by providing a connecting mechanism between the diaphragm of the pump and the actuating motor which is collapsible against the force of biasing springs along an axis through the mechanism connections. The mechanism comprises a cross-

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head connected to a motor operated eccentric and mounted for limited reciprocation against the force of a biasing spring between parallel legs of a closed frame member. The mechanism is enclosed within a housing with an internal configuration adapted to confine a quantity of lubricating oil for the lubrication of the moving parts of the mechanism.

With this form of mechanism and housing adequate lubrication is provided for the mechanism and the force required to start the diaphragm reciprocating or pumping where there is very little or no pressure in the pumping chamber is the force required to overcome the friction of the moving parts of the mechanism.

The novel features which are characteristic of the present invention are set forth with particularity in the appended claims. The invention itself, however, will be best understood by reference to the following specification when considered in connection with the accompanying drawings in which Figure 1 is a side view of the fuel pump partly in section and partly broken away, embodying one form of the present invention; Figure 2 is an end view of the mechanism and mechanism housing taken substantially along the line 2—2 of Figure 1 and illustrating the relative position of the mechanism parts when the mechanism is pumping; Figure 3 is a side view similar to Figure 2 illustrating the relative position of the mechanism parts when the pump is idling; Figure 4 is an exploded perspective view of the relatively slidable mechanism parts illustrated in Figures 1, 2 and 3; Figure 5 is an end view of the enclosing housing and one modification of the mechanism of the present invention and Figure 6 is a side view of the mechanism and housing illustrated in Figure 5.

Referring now to the drawings and more particularly to Figure 1 there is illustrated a fuel pump having a casing formed of a plurality of sections and comprising a main body member 1, a cap 2, a partitioning member 3 and a mechanism housing member 4. The main body member 1 is provided with threaded inlet and outlet passages 5 and 6 respectively and a lateral passage 7 separated from the inlet passage 5 by a plug insert 8. A receptacle 9 positioned adjacent a recess 10 in the main body 1 provides a collecting chamber 11 for sediment drawn into the fuel pump from a reservoir (not shown). The receptacle 9 is held in operative position by a spring clamp 12 and an adjustable thumb screw 13. A gasket 14 spaced between the main body member 1 and the receptacle 9 forms a liquid-tight seal. Communication is provided between the sediment chamber 11 and the passages of the main body member 1 through ports 15 and 16 formed adjacent the inlet passage 5 and the lateral passage 7 respectively. A cylindrical filter screen 17 positioned adjacent a boss 18 extending downwardly from the main body member 1 forms a barrier to the passage of sediment into the lateral passage 7. The filter screen 17 is held in position by a screw-threaded member 19.

Pulsator chambers 20 and 21 communicating with the inlet and outlet passages 5 and 6 respectively, are provided by forming the main body member 1 with an integral section 22 and spacing a flexible diaphragm 23 of suitable material between the main body member 1 and cap 2.

A disk-shaped member 24 is positioned in a recess 25 in the main body member and cooperates with the integral section to form valve controlled communicating passages between the pumping chamber 28 and the inlet and outlet passages of the pump. The disk-shaped member is held in its position of cooperation against a gasket 26 by a screw-threaded member 27.

The pumping chamber 28 is formed with a movable wall comprising a flexible diaphragm 29 of suitable material clamped about its peripheral edge between the main body member 1 and the partitioning member 3. To provide means for actuating the diaphragm 29 it is connected to an operating stem 32 slidably mounted in a bushing member 33 positioned in a central bore in the partitioning member 3. The stem 32 and diaphragm 29 are assembled into a unitary structure by forming the stem 32 with one end 31 of smaller diameter than the main body of the stem and inserting the end 31 in a central hole 30 in the diaphragm. Disk-shaped members 34 and 35 are spaced on opposite sides of the diaphragm and the assembly is secured by peening the end 31 to secure a washer 36 having a central aperture slightly larger than the end 31. With the disk-shaped members arranged as above mentioned, the flexible portion of the diaphragm is limited to the area between the peripheral edges of the disks and the inner edges of the casing members 1 and 3.

Valve controlling means for the pumping chamber are provided by a pair of one-way valves inversely arranged to provide liquid flow in one direction to and from the pumping chamber. The valve controlling means comprise a pair of disks 37 normally held in contact with the valve seats of inserts 38 by springs 39. Passages 40 and 41 are provided in the disk member 24 and integral section 22 respectively for communication between the pumping chamber 28 and the inlet and outlet passages 5 and 6.

Actuation of the diaphragm 29 is obtained by a low voltage, low starting torque, electric motor 42 having its shaft 43 formed with an eccentric portion 44. The motion of the rotating eccentric portion 44 is transferred to the diaphragm stem 32 through a lost motion mechanism, one form being illustrated in detail in Figs. 2, 3 and 4, and a modification thereof being illustrated in Figs. 5 and 6.

The lost motion mechanism of Figs. 2, 3 and 4 comprises a bifurcated member 45 pivotally connected to the diaphragm stem 32 through a member 46 fixedly attached to the arms of the bifurcated member 45. A cross head 47 provided with slots 48 and 49 is slidably mounted on the bifurcated member 45 and pivotally connected through a link 50 to the eccentric portion 44 of

motor shaft 43. The crosshead 47 is normally biased downwardly on the bifurcated member 45 by helical spring members 51 mounted on the arms. An oblong slot 52 in a projecting arm 53 on the bifurcated member 45 cooperates with a pin 54 connecting the link 50 with the crosshead 47 to limit the relative slidability of the cross member 47. An arm 55 projecting downwardly from the bifurcated member 45 and recessed in a well 56 in the mechanism housing 4 provides a guide for the reciprocating motion of the bifurcated member 45.

The lower portion of the lost motion mechanism housing 4 is formed to contain a supply of lubricating material for the lost motion mechanism. The parts are lubricated by immersion of the lower portion of the mechanism in the lubricant and the motion of the mechanism when in operation. To provide against the loss of the lubricant, gaskets 57 and 58 form liquid-tight seals where the mechanism housing 4 and the partitioning member 3 and motor housing are joined. To insure against loss of the lubricant irrespective of the position of the fuel pump, the boss 59 projecting downwardly from the partitioning member 3 is provided. The boss forms a wall or barrier against loss of lubricant through the space between the stem 32 and the bushing 33; it being adapted to confine a predetermined quantity of lubricant in the well formed by the boss, the wall of the partitioning member 3 and mechanism housing 4 when the pump is in an inverted position.

In operation the inverse arrangement of the valves provides for liquid flow in one direction only through the pumping chamber. On the downstroke of the diaphragm 29, a vacuum is created in the pumping chamber which causes fuel to be drawn from the reservoir (not shown) through the inlet passages of the pump to the pumping chamber. When the movement of the diaphragm is reversed the fuel is forced from the pumping chamber to the engine carburetor (not shown). As the float valve of the carburetor controls the admission of fuel to the carburetor and the supply of fuel is at times greater than the demand of the engine, pressure is built up in the pumping chamber exerting a force on the diaphragm tending to restrict its movement. When this force becomes greater than the force exerted by biasing springs 51 on the reciprocating member 47, the reciprocating member slides on the connecting rod or bifurcated member 45 and the fuel flow from the pump is reduced. With the pressure in the pumping chamber at a maximum the reciprocating member reciprocates on the connecting rod through a stroke equal to the throw of the eccentric on the motor shaft and the diaphragm remains idle. Likewise as the pressure in the pumping chamber is reduced the force exerted by the biasing springs on the reciprocating member gradually overcomes that exerted on the diaphragm and the diaphragm movement becomes equal to the throw of the eccentric.

In the modification illustrated in Figs. 5 and 6, the mechanism comprises an oblong or closed frame member 60 pivotally connected at the midpoint of its upper crossarm to the diaphragm stem 32 and a crosshead 61 slidably mounted between the legs of the frame and connected through a depending projection to the lower crossarm of the frame. The crosshead 61 is provided with a circular aperture 62 which is adapted to receive for rotation therein an eccentric 63 fitted to the end of the motor shaft 43. The depending projection is provided with a slotted recess 64 adapting it to slidably receive the lower crossarm of the frame member 60. An oblong slot 65 provided in the lower crossarm of the frame permits limited reciprocation of the crosshead 61 in the frame member 60 while a biasing spring 66 resists reciprocation of the crosshead and normally forces the crosshead downwardly to the limit of its travel on the frame. To insure lubrication of the eccentric 63 an oil hole is provided in the top of the crosshead.

From the description of the modification it will be clear that the operation of the cooperating parts will be the same as that described hereinabove in connection with the mechanism illustrated in Figs. 2, 3 and 4; both providing a variable stroke to the diaphragm determined by the pressure in the pumping chamber.

With these forms of mechanism it will be obvious that on starting the pump with little or no pressure in the pumping chamber the only force required of the actuating motor is that required to overcome the friction in the moving parts. A pump with such a mechanism is suited to operation by small direct current motors of low starting torque characteristics such as those adapted to operation in the low voltage electrical system of automotive vehicles. Furthermore, such motors would not be stalled when the pressure is built up in the pumping chamber as the torque characteristic increases with increases in the running speed.

A fuel pump with an actuating mechanism such as hereinabove described will find particularly useful application in automotive vehicles and aircraft where it is preferred to locate the pumps in positions remote from the engine. Such a pump has the additional advantage in that its actuating source may be small, light in weight and characterized by low power requirements.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. In a fuel pump, a pumping chamber in which the pressure varies, a flexible diaphragm forming one wall of said pumping chamber affected by said pressure, a low starting torque electric rotary driving motor having an eccentric for actuating said diaphragm and a mechanism operatively connecting said diaphragm and said eccentric for imparting a variable stroke to said diaphragm determined by the pressure on the diaphragm, said mechanism comprising relatively movable members, one forming a guide member for the other and linearly movable with respect to the other, said members being attached respectively to said diaphragm and said eccentric and a spring positioned between said members for yieldingly urging one of said members to an extreme position on the other of said members.

2. In a fuel pump, a pumping chamber, a flexible diaphragm forming one wall of said pumping chamber, a low starting torque electric rotary driving motor having an eccentric for actuating said diaphragm and a mechanism operatively connecting said diaphragm and said eccentric for imparting a variable stroke to said diaphragm, said mechanism comprising a bifurcated guide member and a member attached thereto and slidable thereon and a spring interposed between said members for yieldingly urging said slidable member to an extreme position on said bifurcated member, said members being operatively attached to said diaphragm and said eccentric respectively and responsive against the pressure of said spring and to predetermined pressures on said diaphragm to take various positions with respect to each other to vary the stroke of said diaphragm.

3. In a fuel pump, a pumping chamber, a movable diaphragm forming one wall of said pumping chamber, a low starting torque rotary driving motor having an eccentric shaft for actuating said diaphragm and a mechanism operatively connecting said diaphragm and said eccentric shaft for imparting a variable stroke to said diaphragm, said mechanism comprising a bifurcated member operatively connected to said diaphragm, a member attached to and slidable on said bifurcated member and operatively attached to said shaft and springs interposed between said members to yieldingly urge said slidable member to an extreme position on said bifurcated member, said members being responsive to predetermined pressures on said diaphragm to overcome the pressure of said springs and vary the relative positions of said members with respect to each other to provide variable stroke diaphragm operation.

4. In a fuel pump, a casing constructed to form a pumping chamber and a mechanism housing, a movable diaphragm forming one wall of said pumping chamber and having a stem projecting into said mechanism housing, a partition member having a centrally located boss extending into said mechanism housing for slidably mounting said stem, said boss being adapted in cooperation with said partition member and said mechanism housing to confine a predetermined amount of lubricant in said mechanism housing, a rotary driving member having an eccentric shaft for actuating said diaphragm and a mechanism operatively connecting said stem and said eccentric shaft for imparting a variable stroke to said diaphragm, said mechanism comprising a bifurcated member operatively connected to said stem, a crosshead attached to and slidable on said bifurcated member and operatively attached to said eccentric shaft, and springs positioned between said bifurcated member and said crosshead to yieldingly urge said crosshead to an extreme position on said bifurcated member said bifurcated member and crosshead being responsive to pressures on said diaphragm to overcome the pressure of said springs and vary the relative position of said crosshead and said bifurcated member with respect to each other and provide variable stroke operation for said diaphragm.

5. In a pump, a pumping chamber, a reciprocating member forming one wall of said pumping chamber, a low starting torque, electric actuator for said reciprocating member and a mechanism operatively connecting said actuator and said reciprocating member, said mechanism comprising a closed frame member and a crosshead attached to and slidably mounted within said frame member and a spring positioned between said frame member and said crosshead to yieldingly urge said crosshead to an extreme position on said frame member, said member; said frame member and said crosshead being attached to said reciprocating member and said actuator respectively.

6. In a fuel pump, a casing constructed to form a pumping chamber and a mechanism housing, a movable diaphragm forming one wall

of said pumping chamber and having a stem projecting into said mechanism housing, a partition member having a centrally located boss extending into said mechanism housing for slidably mounting said stem, said boss being adapted in cooperation with said partition member and said mechanism housing to confine a predetermined amount of lubricant in said mechanism housing, a low starting torque, electric rotary driving member having an eccentric shaft for actuating said diaphragm and a mechanism operatively connecting said stem and said shaft for imparting a variable stroke to said diaphragm, said mechanism comprising a closed frame member operatively connected to said stem, a crosshead attached to and slidable within the closed frame member and operatively attached to said eccentric shaft, and springs positioned between said frame member and said crosshead to yieldingly urge said crosshead to an extreme position on the closed frame member.

7. In a fuel pump, a pumping chamber in which the pressure varies, a flexible diaphragm forming one wall of said chamber affected by said pressure, a low voltage, low starting torque electric motor for reciprocating said diaphragm and a mechanism operatively connecting said diaphragm and said motor for imparting a variable stroke to said diaphragm determined by the pressure on the diaphragm, said mechanism comprising relatively movable members, one forming a guide member for the other and linearly displaceable with respect to the other, spring means positioned between said members, said means being adapted to urge said members to spaced apart positions said members being connected respectively to said diaphragm and said motor.

8. In a fuel pump, a pumping chamber, a flexible diaphragm forming one wall of said chamber, a low voltage, low starting torque electric motor for reciprocating said diaphragm and a mechanism operatively connecting said diaphragm and said motor for imparting a variable stroke to said diaphragm, said mechanism comprising an enclosed frame member operatively connected to said diaphragm, a crosshead slidably attached to said frame member and connected to said electric motor and a spring yieldingly urging said crosshead to an extreme position on said frame, said spring being adapted to yield in response to predetermined pressures in said pumping chamber to vary the length of stroke of said diaphragm.

9. In a fuel pump, a casing constructed to form a pumping chamber and a mechanism housing, a flexible diaphragm forming one wall of said pumping chamber and having a stem projecting into said mechanism housing, a partition member having a centrally located boss extending into said mechanism housing for slidably mounting said stem, said boss being adapted in cooperation with said mechanism housing and said partition member to trap a predetermined amount of liquid in said mechanism housing, a low voltage, low starting torque electric motor having an eccentric shaft for reciprocating said diaphragm and a variable stroke mechanism operatively connecting said stem and shaft, said mechanism comprising a closed frame member operatively connected to said stem, a crosshead mounted in said frame member and operatively connected to said shaft and a spring positioned between said crosshead and said frame for yieldingly urging said crosshead to an extreme position on said frame, said spring being adapted to yield in response to predetermined pressures in said pumping chamber to vary the length of stroke of said diaphragm.

10. In a fuel pump, a casing constructed to form a pumping chamber and a mechanism housing, a flexible diaphragm forming one wall of said pumping chamber and having a stem projecting into said mechanism housing, a partition member having a centrally located boss extending into said mechanism housing for slidably mounting said stem, said boss being adapted in cooperation with said mechanism housing and said partition member to trap a predetermined amount of liquid in said housing, a low voltage, low starting torque electric motor having an eccentric shaft for reciprocating said diaphragm and a variable stroke mechanism operatively connecting said shaft and said stem, said mechanism comprising a closed frame member connected at one end to said stem and slidably mounted at its opposite end in a slot in said housing, a crosshead slidably attached to said frame and connected to said shaft and a pair of springs positioned between said frame member and said crosshead for yieldingly urging said crosshead to an extreme position on said frame, said springs being adapted to yield in response to predetermined pressures in said pumping chamber to vary the length of stroke of said diaphragm.

11. In a fuel pump, a casing constructed to form a pumping chamber and a mechanism housing, a flexible diaphragm forming one wall of said pumping chamber and having a stem projected into said mechanism housing, a second flexible diaphragm forming another wall of said pumping chamber, a partition member having a centrally located boss extending into said mechanism housing for slidably mounting said stem, said boss being adapted in cooperation with said mechanism housing and said partition member to trap a predetermined amount of liquid in said mechanism housing, a low voltage, low starting torque electric motor having an eccentric shaft for reciprocating said diaphragm and a variable stroke mechanism operatively connecting said shaft and said stem, said mechanism comprising a closed frame member connected at one end to said stem and slidably mounted at its opposite end in a slot in said housing, a crosshead slidably attached to said frame and connected to said shaft and spring means positioned between said crosshead and said frame member for yieldingly urging said crosshead to an extreme position on said frame, said spring means being adapted to yield in response to predetermined pressures in said pumping chamber to vary the length of stroke of said diaphragm.

12. In a fuel pump having driven means, an actuator for imparting reciprocatory motion to said means and a lost motion mechanism connecting said driven means and said actuator and permitting variable stroke operation of said driven means in response to varying pressures on said driven means, said mechanism comprising a closed frame member having spaced leg portions and connected to said driven member, a crosshead attached to said actuator and having means for engaging said legs to slidably attach said crosshead to said frame and spring means positioned between said crosshead and

said frame for yieldingly urging said crosshead to an extreme position on said frame, said spring means being adapted to yield in response to predetermined pressures in said pump to vary the stroke of said driven means.

13. In a fuel pump having driven means upon which the pressure varies, a low starting torque electric driving motor having an eccentric for imparting reciprocatory motion to said driven means and a mechanism operatively connecting said driven member and said eccentric for transferring the rotary motion of said motor into reciprocatory motion of said driven member, said mechanism comprising relatively movable attached members, one of said attached members being connected to said eccentric and the other to said driven member and spring means positioned between said relatively movable members for yieldingly urging said relatively movable members in spaced apart relation while permitting a foreshortening of the distance between said members against the pressure of said spring means to simultaneously vary the stroke of said driven member in response to variations in pressure of said pump.

14. In a fuel pump having driven means, an actuator for imparting reciprocatory motion to said driven means, and a lost motion mechanism connecting said actuator and driven means for permitting variable stroke operation of said driven means, said mechanism comprising a closed frame member having spaced leg portions, said frame member being connected to said driven member, a crosshead slidably attached to said frame member and to said actuator, said crosshead having spaced slots therein for receiving said spaced leg portions and spring means positioned between said frame member and said cross member for yieldingly urging said crosshead to an extreme position on said frame member, said said spring means being adapted to yield in response to predetermined pressures on said driven means to vary the stroke thereof.

15. In a fuel pump having a driven means, a rotary actuator having an eccentric for imparting reciprocatory motion to said driven means and a lost motion mechanism connecting said eccentric and said driven means for permitting variable stroke operation of said driven means, said mechanism comprising a closed frame member connected to said driven member and having spaced parallel leg portions, a crosshead slidably attached to said frame and to said eccentric, said crosshead having spaced slots therein for receiving said leg portions and guiding the movements of said crosshead on said frame, a link attached to said crosshead for movement therewith, said link having an aperture therein for receiving said eccentric and positively connecting said eccentric and said mechanism, and spring means positioned between said crosshead and said frame member for yieldingly urging said crosshead to an extreme position on said frame member, said spring means being adapted to yield in response to predetermined pressures on said driven means to vary the stroke thereof.

16. In a fuel pump having driven means, a rotary actuator having an eccentric for imparting reciprocatory motion to said driven member, and a lost motion mechanism connecting said eccentric and driven means for permitting variable stroke operation of said driven means, said mechanism comprising a closed frame member connected to said driven member and having spaced parallel leg portions, a crosshead slidably mounted on said frame with portions engaging said leg portions, said crosshead having apertures therein journalling said eccentric, means connecting said crosshead to said frame to permit limited relative movement therein and spring means positioned between said frame member and said crosshead for yieldingly urging said crosshead to an extreme position on said frame, said spring means being adapted to yield in response to predetermined pressures on said driven means to vary the stroke thereof.

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