

July 1, 1952

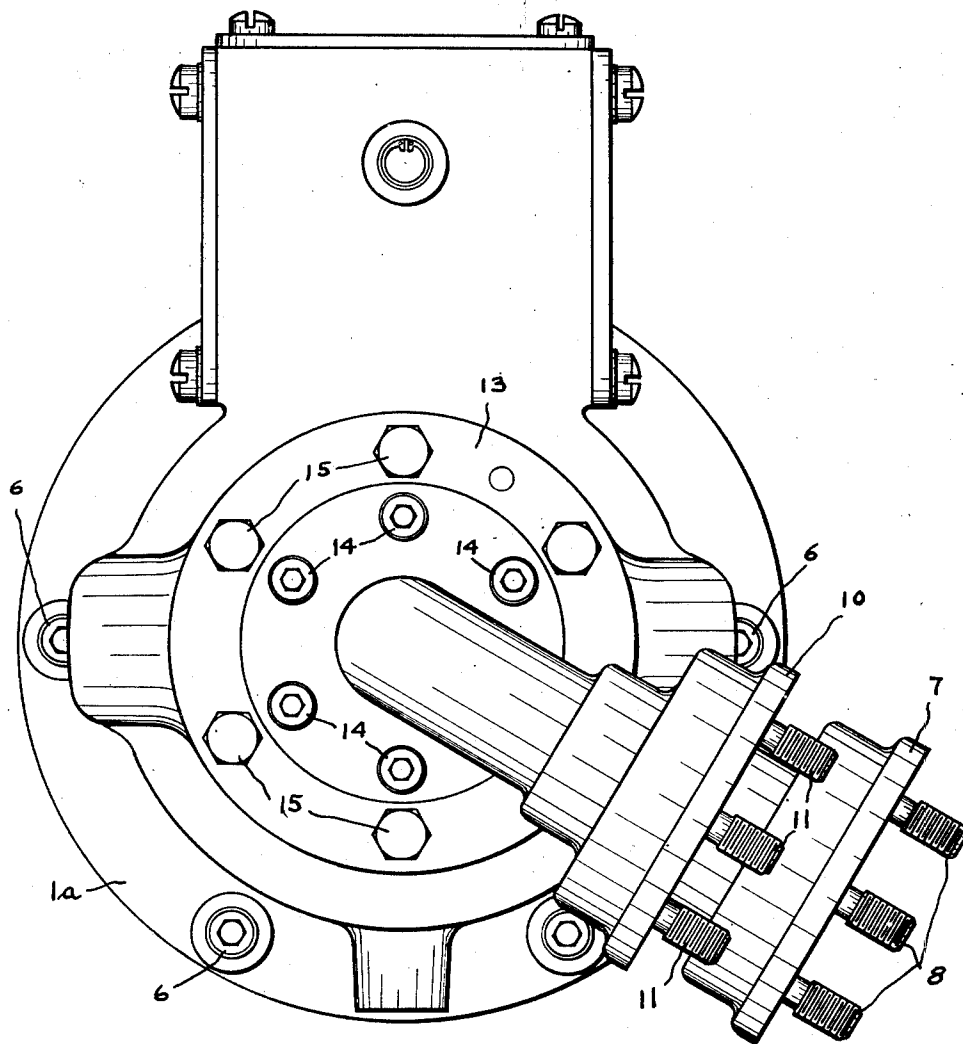
M. J. BERLYN ET AL

2,601,830

PUMP

Filed May 14, 1949

9 Sheets-Sheet 1



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9 Sheets-Sheet 2

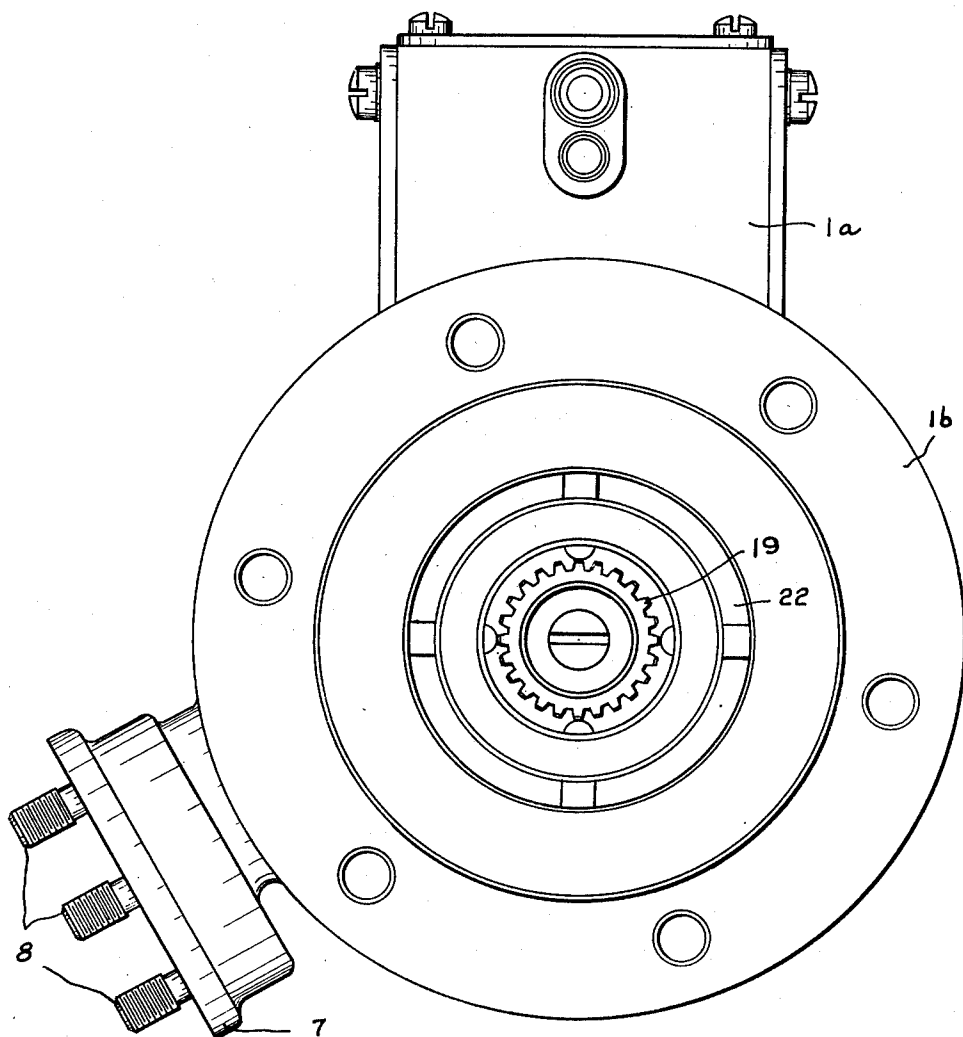


Fig. 2.

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9 Sheets-Sheet 3

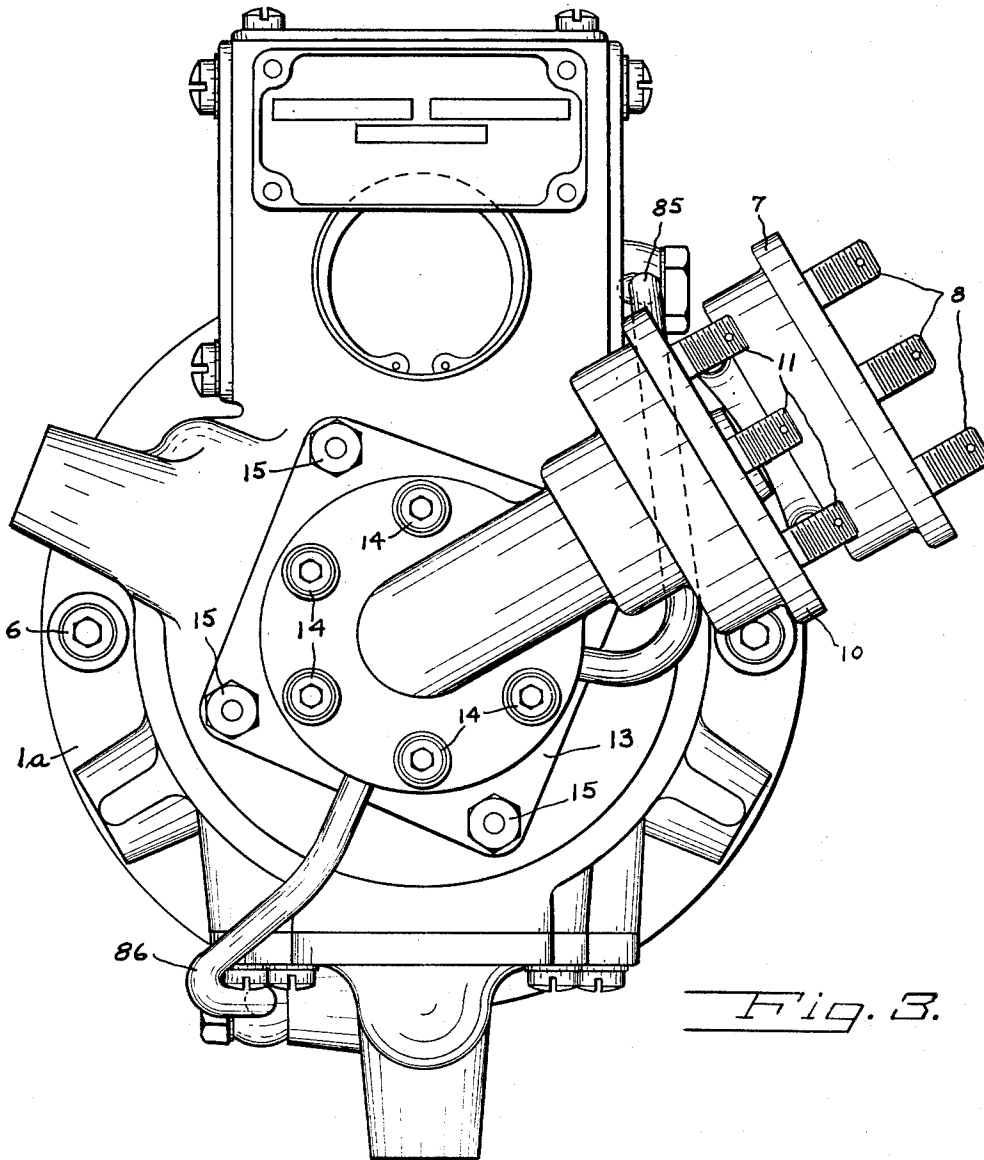


Fig. 3.

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9 Sheets-Sheet 4

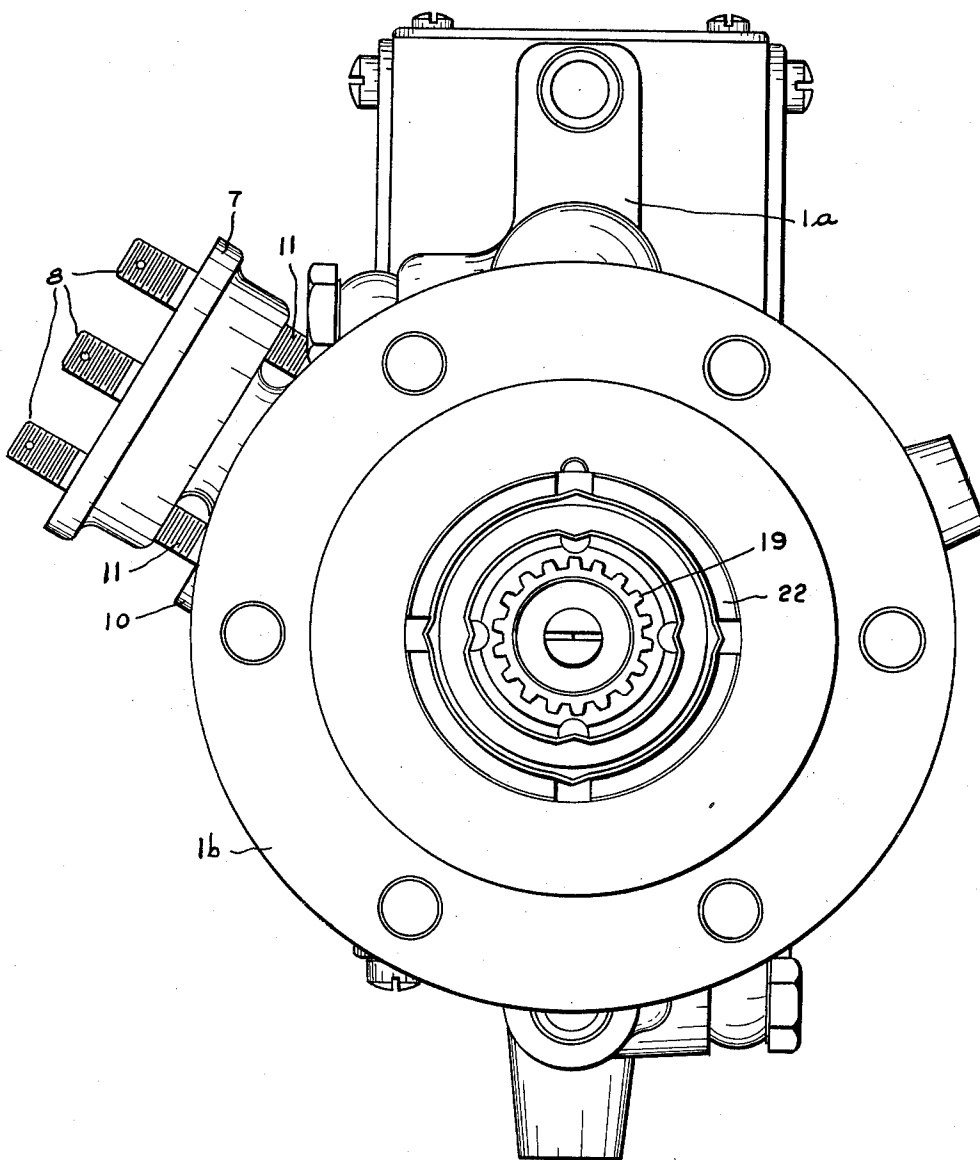


Fig. 4.

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9 Sheets-Sheet 5

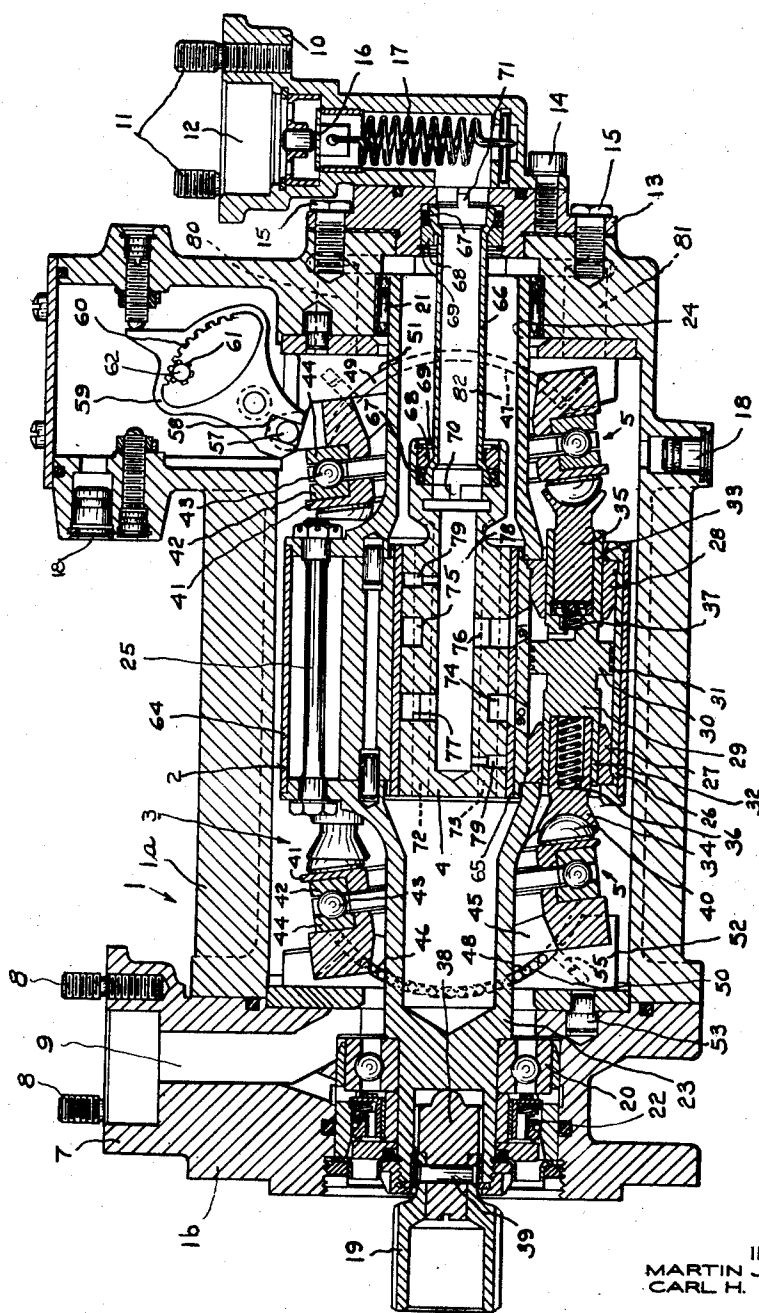


Fig. 5.

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9 Sheets-Sheet 6

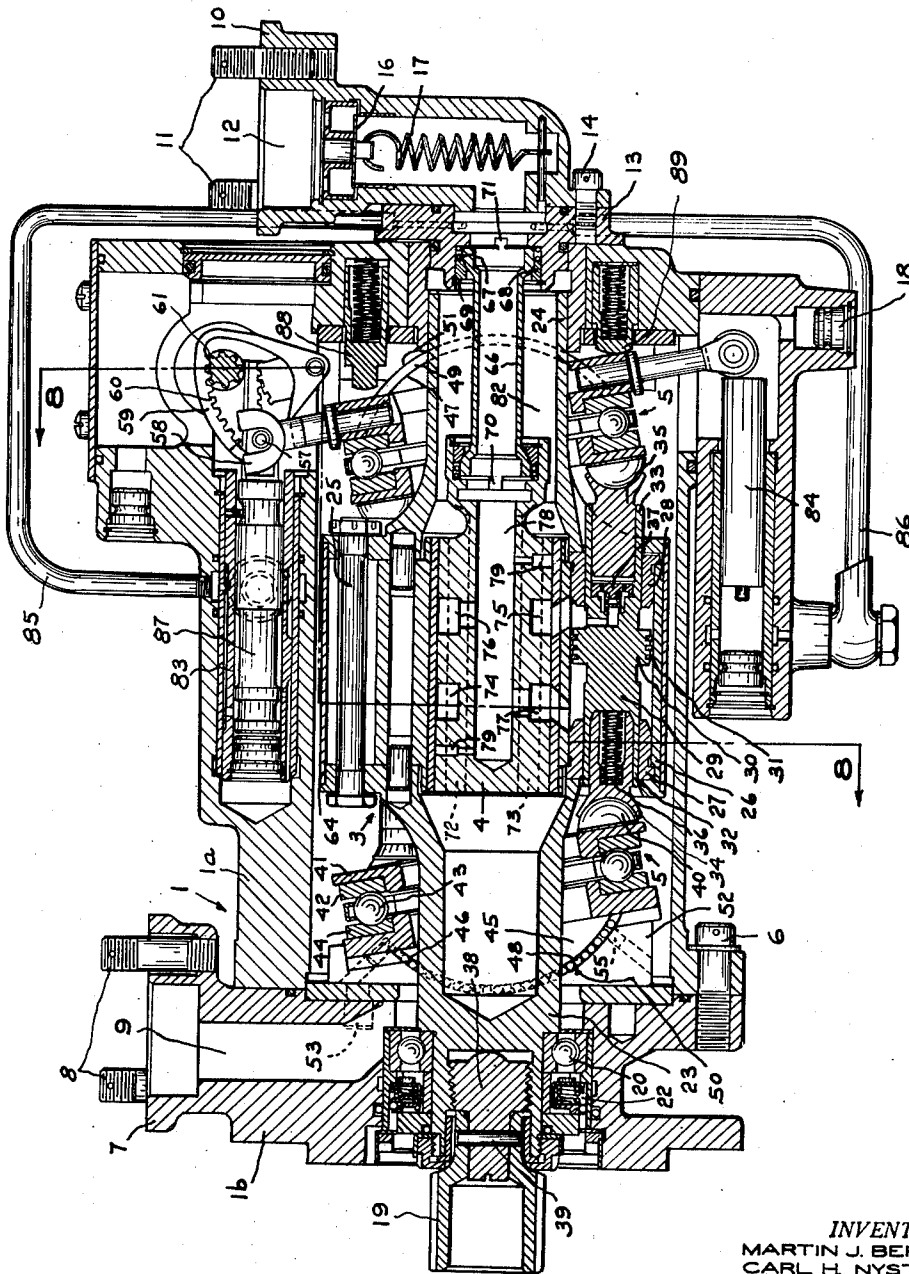


Fig. 8.

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9 Sheets-Sheet 7

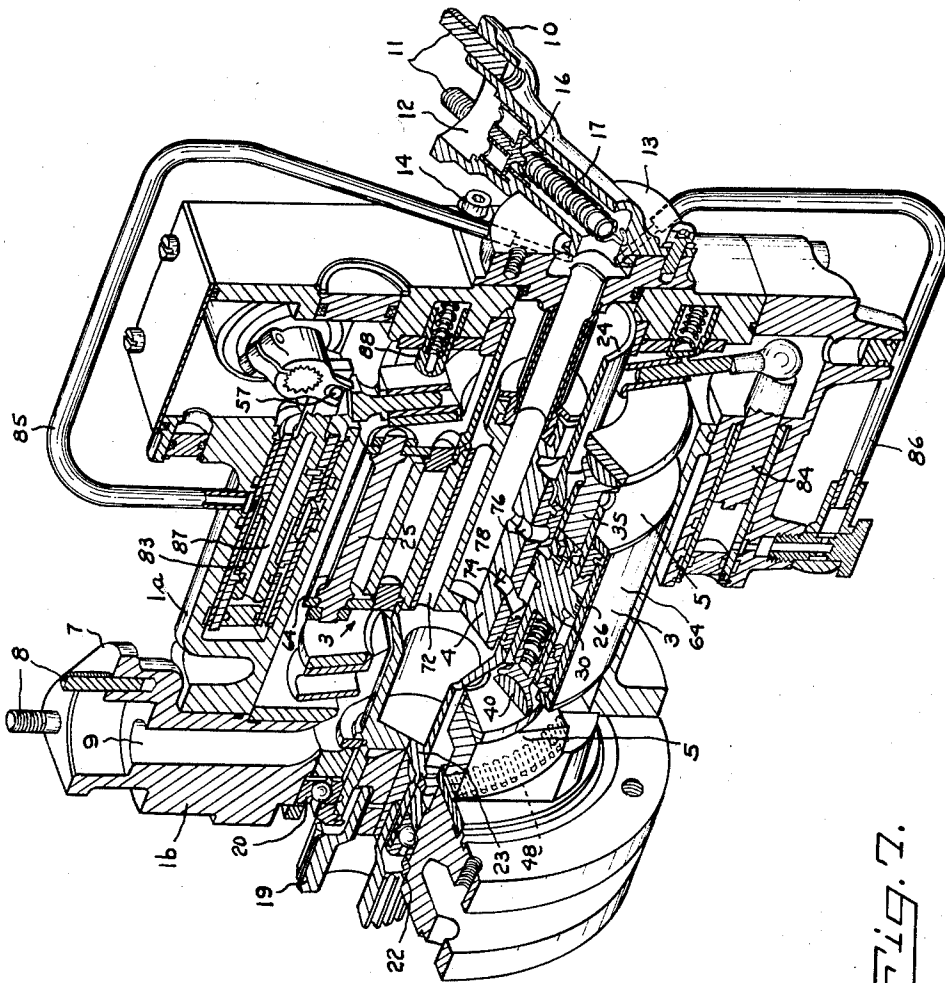


Fig. 7.

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9 Sheets-Sheet 8

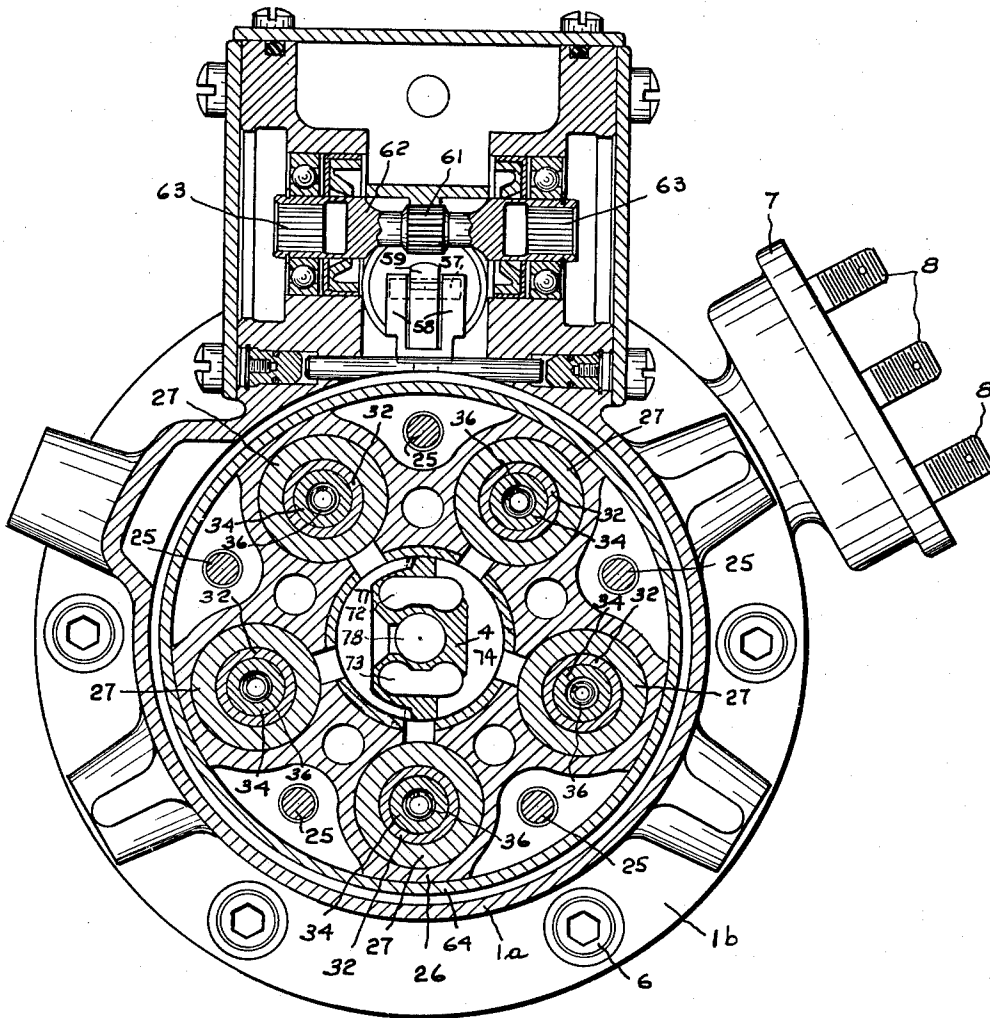


Fig. 8.

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9 Sheets-Sheet 9

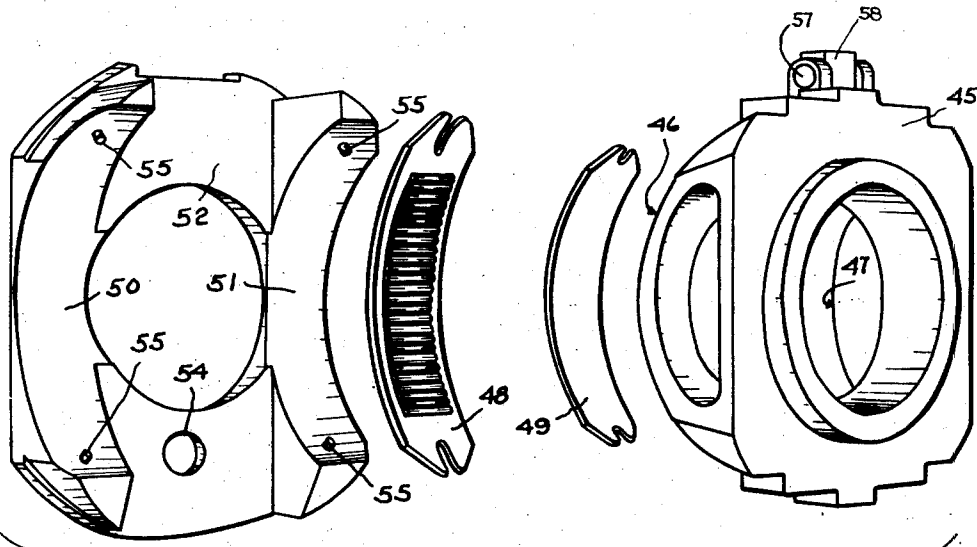


Fig. 10.

Fig. 9.

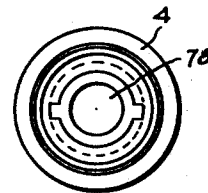
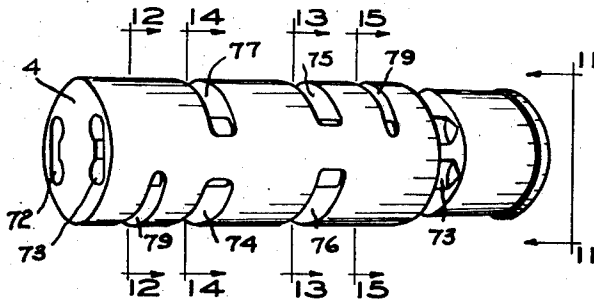


Fig. 11.

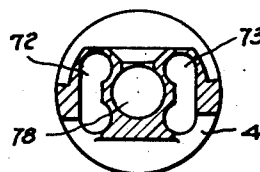
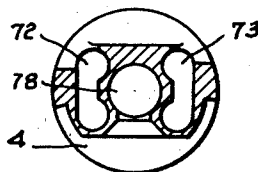
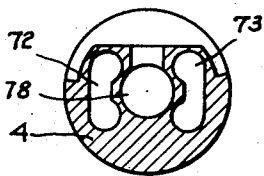


Fig. 12.

Fig. 13.

Fig. 14.

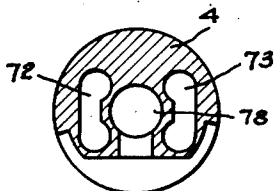


Fig. 15.

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UNITED STATES PATENT OFFICE

2,601,830

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Application May 14, 1949, Serial No. 93,392

12 Claims. (Cl. 103—162)

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This invention relates to a new and improved fuel injection or metering pump of the type in which all the fuel discharges from a single outlet and in which the displacement of fluid per pump revolution is infinitely adjustable from zero delivery to the maximum capacity of the pump.

An object of the invention is to provide a new and improved relatively compact swash plate type pump embodying a new and improved control arrangement.

Another object of the invention is to provide a low pressure centrifugal booster or supply pump and a higher pressure delivery pump and wherein the booster pump may be employed to boost or increase the pressure of fuel supplied thereto and supply such fuel to the higher pressure pump.

Another object of the invention is to provide a device of the type set forth wherein both centrifugal pumping and reciprocating plunger pumping actions may be employed.

Another object of the invention is to provide such a device which is relatively compact and light weight and wherein the fluid pumped is employed as a lubricating or wetting agent making unnecessary the provision of any separate system of lubrication with grease or lubricating oil.

Another object of the invention is to provide a pump of the type set forth which is of the barrel type and which may employ a rotating plunger housing of such form as to provide, if desired, a centrifugal pressure booster in cooperation with a plurality of double acting plungers which are actuated by two parallel swash plates which may be adjusted in angular relation to the pump shaft axis to vary the displacement per revolution of the pump.

Another object is to provide a device of the type set forth and in which the entire plunger or piston stroke is employed for effective pumping thereby giving a theoretical volumetric efficiency of one hundred per cent.

Another object of the invention is to provide a pump of the type set forth which is double acting and employs both sides of the plunger and which takes in fuel during substantially the entire length of the inlet stroke and discharges during substantially the entire delivery stroke and which employs no plunger controlled ports.

Another object is to provide a device of the type set forth which avoids the use of any spring or tension members in the plunger driving means thereby providing a relatively simplified and trouble-free construction, and particularly allows

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considerable simplification in the design of the joints having universal motion which are essential in any swash plate design.

Another object of the invention is to provide a device of the type set forth wherein piston rings are provided on the pumping portion of the plunger to seal said portion within its bore.

Another object of the invention is to provide such a device wherein fuel is introduced into the housing at one end of the pump at a point near the axis of the pump whereby the fuel will be forced through the entire length of the pump and, therefore, acts as a cooling and wetting agent for all of the moving parts of the pump.

Another object is to provide a device of the type set forth wherein an internal balancing of forces is employed to eliminate any free axial forces entirely and reduce free radial forces to a minimum, which balancing eliminates as far as possible the use of bearings which are expensive and heavy and which require additional space thus increasing the size of the device.

Another object is to provide a device of the type set forth wherein free axial forces are reduced by providing an odd number of plungers to provide a non-pulsating flow or discharge.

Another object of the invention is to provide a device of the type set forth wherein a double acting plunger is provided which employs both sides of the pumping portion of the plunger and wherein the plunger rod portions on either side of each plunger pumping portion are of identical diameter so that a given fluid pressure produces the same axial force on either side of each plunger thereby providing axial balance.

Other objects and advantages of the invention will be apparent from the following description taken in connection with the accompanying drawings and it will be understood that changes may be made in the details of construction and arrangement of parts without departing from the scope of the invention as expressed in the accompanying claims.

Referring to the drawings:

Fig. 1 is a rear view of the preferred form of the invention;

Fig. 2 is a front view of the preferred form of the invention;

Fig. 3 is a view similar to Fig. 1 but showing another form of the invention;

Fig. 4 is a view similar to Fig. 2 but showing the form of invention of Fig. 2;

Fig. 5 is a longitudinal sectional view of the preferred form of the invention;

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Fig. 6 is a longitudinal sectional view of the form of the invention shown in Figs. 3 and 4;

Fig. 7 is an isometric view of the form of the invention shown in Figs. 3, 4 and 6;

Fig. 8 is a sectional view taken on line 8—8 of Fig. 6 looking in the direction of the arrows;

Fig. 9 is an exploded view of the control plate assembly;

Fig. 10 is a perspective view of the valve member;

Fig. 11 is an end view taken on line 11—11 of Fig. 10 looking in the direction of the arrows;

Fig. 12 is a sectional view taken on line 12—12 of Fig. 10 looking in the direction of the arrows;

Figs. 13 is a sectional view taken on line 13—13 of Fig. 10, looking in the direction of the arrows;

Fig. 14 is a sectional view taken on line 14—14 of Fig. 10, looking in the direction of the arrows; and

Fig. 15 is a sectional view taken on line 15—15 of Fig. 10, looking in the direction of the arrows.

Referring more particularly to the drawings wherein similar reference characters designate corresponding parts throughout, the device shown embodying the invention comprises a housing indicated generally at 1 in which is mounted a rotating plunger housing indicated generally at 2 in which are a plurality of double acting plunger assemblies indicated generally at 3.

Within the plunger housing 2 is provided the stationary central valve 4.

Within the housing 1 and adjacent the opposite ends of the rotating plunger housing 2 are positioned the variable swash plates 5 which act to effect the pumping strokes of the double acting plungers in the plunger assemblies 3 and said swash plates may be adjusted to vary or adjust the stroke of the plungers in said assemblies.

The housing 1 of the device is composed of two castings 1a and 1b secured together by bolts 6, and the member 1b serves also as a mounting flange for mounting the device on an engine in the usual manner.

The member 1b also is provided with the fuel inlet pad 7 adapted to be connected to a fuel supply line, not shown, by the studs 8, and said member 1b is provided with the fuel passageway 9 for supplying fuel to the interior of the housing 1. Fuel enters the housing 1, through said passageway 9, and all of the working parts of the device are submerged in fuel.

Adjacent the opposite end of housing 1a from member 1b, said housing is provided with the mounting pad 10 adapted to be connected to a fuel discharge line, not shown, by means of the studs 11. Said mounting pad 10 is provided with a discharge opening 12 through which fuel delivered by the device is delivered through the fuel discharge line to the nozzles.

The mounting pad 10 is secured to the flange 13 by means of bolts 14 and said flange 13 is secured to housing 1a by bolts 15.

The spring loaded check valve 16 operated by spring 17 is provided in discharge opening 12 to insure a positive back pressure on the device and also to prevent fuel leaking into the discharge line when the supply pressure is turned on.

The housing 1a has been provided with bleed plugs 18 to bleed the entrapped air for any vertical or horizontal mounting.

The fuel inlet pad 7 and fuel outlet pad 10 are so arranged that they can be revolved in increments of sixty degrees or separately through

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the entire three hundred and sixty degree movement.

The plunger housing assembly 2 is adapted to be revolved about the stationary central valve 4 by the spline drive shaft 19 which operatively engages the engine for driving said shaft 19 and therethrough driving the plunger housing assembly 2 about said valve 4 which distributes an equal amount of fuel to each plunger during its suction stroke and also collects the high pressure discharge during the compression stroke and delivers said discharged fuel through a hollow tube to the discharge passage 12 as hereinafter described.

The housing 1 contains the ball bearing 20 at its front end and roller bearing 21 at its rear end for supporting the rotating plunger housing 2 adjacent its opposite ends and is provided with a face seal 22 for preventing the fuel being pumped from flowing into the lubricating oil of the engine.

The rotating plunger housing 2 is bolted to the flanged shaft 23 and to the flanged shaft 24 by means of the bolts 25.

The flanged shaft 23 is supported at its opposite end by the ball bearing 20 and the flanged shaft 24 is supported at its opposite end by the roller bearing 21, whereby the whole rotating plunger housing assembly is mounted for rotation on those bearings.

The plunger housing assembly 2 contains a plurality of spaced cylinders 26 in each of which is secured a pair of bushings 27 and 28, one at each end of the plunger housing. In each of the cylinders 26 is positioned a double acting plunger 29 which has the central portion 30 of enlarged section having a flexible seal or packing or the three split type piston rings 31 in peripheral grooves therein for sealing across the plunger, and having the two piston rod portions or cross-head guides 32 and 33 lapped into the bushings 27 and 28 respectively.

The plunger rod portions 32 and 33 each have openings adapted to receive one of the tappet rods 34 and 35 respectively. The tappet rod 34 is hollow and contains compression spring 36 which acts to preload the ball thrust bearing in the quantity control or swash plates as hereinafter described.

Just below the tappet rod 35 is a small check valve 37 which opens during the compression or discharge stroke of the plunger 29 and fills the chamber at the end of the tappet rod 35 to hydraulically remove any "lash" in the plunger assembly, so that it maintains its correct length during the suction stroke and thus allows the quantity control plate at the front end of the pump to follow exactly the slant or stroke of the rear quantity control plate as hereinafter described.

The plunger assembly construction thus compensates for any variation in individual length of the plungers and also any differences in expansion or contraction of the main casing 1 which is preferably made of magnesium and the quantity control plates and plunger assemblies which are preferably made of steel.

The flanged shaft 23 is connected to spline drive shaft 19 through spline drive shaft 38 which is connected to spline drive shaft 19 by shear pin 39.

Each of the tappet rods 34 and 35 have a semi-circular depression at its outer end in which is positioned a semi-circular thrust shoe 40 having a flat outer face which engages the surface of

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the thrust plate 41 which is pressed into and rotates with race 42 of ball bearing 43 and race 44 which is pressed onto quantity control plate 45 which has the tracks 46 and 47 adapted to engage the roller bearing 48 and plain bearing 49 which are positioned on the tracks 50 and 51 on saddle 52 which is retained in alignment by pin 53 which is fixed to the housing and extends into opening 54.

Pins 55 extend into grooves or slots 56 in roller bearing 48 and plain bearing 49 to limit the movement of said bearings on the tracks 50 and 51 respectively.

Quantity control plate 45 is provided with pin 57 on which is mounted block 58 which is engaged by control lever 59 which has the toothed segment 60 engaging gear 61 on shaft 62 which is provided with the spline section 63 adapted to engage the splined end of a control shaft, not shown, for adjusting quantity control lever 59.

Around the rotating plunger housing 2 is positioned the sleeve 64 and within said housing is the sleeve liner 65 within which is positioned the stationary central valve 4.

The stationary central valve 4 is connected by the tube or conduit 66 to the discharge or delivery outlet from the device. This tube or conduit 66 is connected at its opposite ends by flexible high pressure joints to the valve 4 and to the flange 13. Each of these flexible high pressure joints comprises a pair of resilient rings 67 backed by a split ring 68 which is retained in position by the snap rings 69 and said tube or conduit 66 is keyed by the keys 70 and 71 at its opposite ends which retains the valve 4 stationary in properly phased relation to the plunger housing.

The stationary central valve 4, as shown in Figs. 5, 6 and 10 to 15 inclusive, has passages 72 and 73 through which the working fluid is led to inlet circumferential ports 74 and 75 to the interior of the spaced cylinders 26 wherein it is pumped by the piston or plunger 30 and then forced through the outlet circumferential grooves 76 and 77 to the central delivery opening 78 from which it is forced through tube or conduit 66 to the discharge line as previously described. The ports 90 and 91 are provided and function alternately as inlet and outlet ports depending upon the direction in which the plunger is moving.

The thrust produced by the pressure on the portions of the valve opposite the pressure ports 76 and 77 is wholly or partially balanced by the fluid pressure in the balancing port 79 which is connected with delivery duct 78.

In the operation of the device fuel passes into the housing 1 through the fuel passageway 9 and the interior of the housing 1 is completely filled with fuel at all times which passes through the passageways 80 and 81 to the chamber 82 from which it passes through the passageways 72 and 73 to the inlet ports 74 and 75 and 90 or 91 which supply fuel to the plunger housings in which it is acted upon by the double ended plungers which then force said fuel through said ports 90 or 91 into the outlets 76 and 77 to the central delivery opening 78 from which it passes through the duct or conduit 66 through the discharge opening 12 to the nozzles.

By adjusting the control lever 59, the angular position of the quantity control members may be varied to vary the quantity of fuel pumped by the plungers 30, and, therefore, control the quantity of fuel delivered by the device.

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An important feature is that by adjusting one of said swash plates 45 to desired position, the other swash plate will be automatically controlled or adjusted through the piston and tappet rods.

In the form of the device shown in Fig. 6, the rear quantity control plate is controlled by two bucking servo pistons 83 and 84. The servo piston 84 urges the quantity control plate to full stroke position while the servo piston 83, which is the largest in area, urges the quantity control plate towards the off stroke position. The pressure for the operation of these servos is supplied from the fuel discharge of the pump through pipe lines 85 and 86. The position of the servo piston 83 is controlled by a slide valve 87 which limits the stroke or position of its sleeve piston 83. The position of the slide valve 87 is controlled by a control system which is part of the control system for the engine on which the device is employed.

In this form of the device the spring loaded stops 88 and 89 are provided to provide a cushion against overload of the actuator gear at the end of the stroke.

The form of the invention shown in Fig. 6 operates in a manner similar to that previously described except for the control system which is controlled by the hydraulically actuated pistons as previously described.

While, as shown in Fig. 8, the device has been shown embodying five plungers, this has been shown by way of illustration and it will be understood that any desired practical number may be employed although for reasons of hydraulic balance it has been found desirable to employ an odd number thereof.

As the whole interior of the housing 1 is completely filled with fuel, all the working parts of the device are, therefore, submerged in fuel.

The ball thrust bearing and needle bearing in the quantity control plate are lubricated and cooled by the fuel that flows through the device.

Also, while quantity control plates are positioned at each end of the device for varying the stroke of the plungers and effecting pumping thereby, only one of said plates needs connection with the control lever as the other plate will be automatically adjusted to proper angular position upon adjustment of the plate connected to the control lever.

It is pointed out that the device actually functions as a fuel injection pump and is of the steady flow or continuous outlet type adapted to supply such flow to a flow splitting device which, in turn, distributes part of the flow to each of the burner nozzles, or to supply such flow to a manifold from which it is distributed to the burner nozzles. Also, the metering device varies the quantity delivered at any desired pressure from zero to maximum delivery.

Also, the whole interior of the pump is normally filled with fuel under supply pump pressure, and is intended for gasoline injection but is also adaptable for pumping kerosene and other fuels and other liquids.

As pointed out above, the quantity of fuel delivered by the device is varied by varying the angular position of the swash plates and the greater the angle, the greater the quantity of fuel delivered. The pressure of the pump is controlled by the flow splitter and the nozzle.

It will be noted that by providing fuel passages in the housing the rotation of the plunger housing will provide a boost action to the fuel, that

is, the plunger housing will function in the manner of a centrifugal booster pump. This booster action can be increased by removal of the outer shell 64 from the plunger housing which would then have a vane or paddle wheel outer surface and thus would increase the pressure of the fuel upon rotation of said plunger housing.

From the foregoing it will be seen that we have provided relatively simple and efficient means for obtaining all of the objects and advantages of the invention.

Having described our invention, we claim:

1. In a device of the character described, a housing having fuel inlet and discharge means, a plunger housing in said housing and mounted for rotation relative thereto, said plunger housing having a plurality of cylinders, a plunger in each of said cylinders, said plungers each comprising a piston portion and oppositely disposed reduced hollow end portions, a tappet rod extending into each of said hollow end portions, and a swash plate at each end of said plunger housing and adapted to effect reciprocation of said tappet rods and thereby effect reciprocation of said plungers in said cylinders upon rotation of said plunger housing.

2. In a device of the character described, a housing having fuel inlet and discharge means, a plunger housing in said housing and mounted for rotation relative thereto, said plunger housing having a plurality of cylinders, a plunger in each of said cylinders, said plungers each comprising a piston portion and oppositely disposed reduced hollow end portions, a tappet rod extending into each of said hollow end portions, one of said tappet rods being hollow and containing a compression spring and a check valve in the plunger adjacent the end of the other tappet rod, and a swash plate at each end of said plunger housing and adapted to effect reciprocation of said tappet rods and thereby effect reciprocation of said plungers in said cylinders upon rotation of said plunger housing.

3. In a device of the character described, a housing having fuel inlet and discharge means, a plunger housing in said housing and mounted for rotation relative thereto, said plunger housing having a plurality of cylinders, a plunger in each of said cylinders, said plungers each comprising a piston portion and oppositely disposed reduced hollow end portions, a tappet rod extending into each of said hollow end portions, each of said reduced portions being positioned in a bushing and a plurality of spaced piston rings in the periphery of said piston portion, and a swash plate at each end of said plunger housing and adapted to effect reciprocation of said tappet rods and thereby effect reciprocation of said plungers in said cylinders upon rotation of said plunger housing.

4. In a device of the character described, a housing having fuel inlet and discharge means, a plunger housing in said housing and mounted for rotation relative thereto, said plunger housing having a plurality of cylinders, a plunger in each of said cylinders, a swash plate at each end of said plunger housing and adapted to effect reciprocation of said plungers in said cylinders, said plunger housing comprising a pair of oppositely disposed flanged shafts and a bushing adjacent each end of each of said cylinders, means for retaining said bushings in said position, and means for securing said bushings and flanged shafts in aligned relation.

5. In a device of the character described, a

housing having fuel inlet and discharge means, a plunger housing in said housing and mounted for rotation relative thereto, said plunger housing having a plurality of cylinders, a plunger in each of said cylinders, a swash plate at each end of said plunger housing and adapted to effect reciprocation of said plungers in said cylinders, said plunger housing comprising a pair of oppositely disposed flanged shafts and a bushing adjacent each end of each of said cylinders, means for retaining said bushings in said position, and means for securing said bushings and flanged shafts in aligned relation, and ball bearings surrounding each of said flanged shafts and positioned between said swash plates and said plungers.

6. In a device of the character described, a housing having fuel inlet and discharge means, a plunger housing in said housing and mounted for rotation relative thereto, said plunger housing having a plurality of cylinders, a plunger in each of said cylinders, a swash plate at each end of said plunger housing and adapted to effect reciprocation of said plungers in said cylinders, said plunger housing comprising a pair of oppositely disposed flanged shafts and a bushing adjacent each end of each of said cylinders, means for retaining said bushings in said position, and means for securing said bushings and flanged shafts in aligned relation, and a stationary valve member within said plunger housing and adapted to deliver fuel to said fuel discharge means.

7. In a device of the character described, a housing having fuel inlet and discharge means, a plunger housing in said housing and mounted for rotation relative thereto, said plunger housing having a plurality of cylinders, a plunger in each of said cylinders, a swash plate at each end of said plunger housing and adapted to effect reciprocation of said plungers in said cylinders, said plunger housing comprising a pair of oppositely disposed flanged shafts and a bushing adjacent each end of each of said cylinders, means for retaining said bushings in said position, and means for securing said bushings and flanged shafts in aligned relation, and ball bearings surrounding each of said flanged shafts and positioned between said swash plates and said plungers, and a stationary valve member within said plunger housing and adapted to deliver fuel to said fuel discharge means.

8. In a device of the character described, a housing having fuel inlet and discharge means, a plunger housing in said housing and mounted for rotation relative thereto, said plunger housing having a plurality of cylinders, a plunger in each of said cylinders, said plungers each comprising a piston portion and oppositely disposed reduced hollow end portions, a tappet rod extending into each of said hollow end portions, and a check valve in the plunger adjacent the end of one of said tappet rods, and a swash plate at each end of said plunger housing and adapted to effect reciprocation of said tappet rods and thereby effect reciprocation of said plungers in said cylinders upon rotation of said plunger housing.

9. In a device of the character described, a housing having fuel inlet and discharge means, a plunger housing in said housing and mounted for rotation relative thereto, said plunger housing having a plurality of cylinders, a plunger in each of said cylinders, said plungers each comprising a piston portion and oppositely disposed reduced hollow end portions, a tappet rod extending into each of said hollow end portions, and an inwardly opening check valve adjacent the end of one

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of said tappet rods, and a swash plate at each end of said plunger housing and adapted to effect reciprocation of said tappet rods and thereby effect reciprocation of said plungers in said cylinders upon rotation of said plunger housing.

10. In a device of the character described, a housing having fuel inlet and discharge means, a plunger housing in said housing and mounted for rotation relative thereto, said plunger housing having a plurality of cylinders, a plunger in each of said cylinders, said plungers being double acting and comprising a piston portion and crosshead guides extending therefrom, and a tappet rod engaging said crosshead guides, and a swash plate at each end of said plunger housing and adapted to effect reciprocation of said tappet rods and thereby effect reciprocation of said plungers in said cylinders upon rotation of said plunger housing.

11. In a device of the character described, a housing having fuel inlet and discharge means, a plunger housing in said housing and mounted for rotation relative thereto, said plunger housing having a plurality of cylinders, a plunger in each of said cylinders, said plungers being double acting and comprising a piston portion and crosshead guides extending therefrom, and a tappet rod engaging said crosshead guides, and a check valve adjacent one end of said crosshead guides, and a swash plate at each end of said plunger housing and adapted to effect reciprocation of said tappet rods and thereby effect reciprocation of said plungers in said cylinders upon rotation of said plunger housing.

12. In a device of the character described, a

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housing having fuel inlet and discharge means, a plunger housing in said housing and mounted for rotation relative thereto, said plunger housing having a plurality of cylinders, a plunger in each of said cylinders, said plungers being double acting and comprising a piston portion and crosshead guides extending therefrom, and a tappet rod engaging said crosshead guides, and a check valve adjacent one end of said crosshead guides and comprising a piston portion and crosshead guides extending therefrom and flexible sealing means on the periphery of said piston portion, and a swash plate at each end of said plunger housing and adapted to effect reciprocation of said tappet rods and thereby effect reciprocation of said plungers in said cylinders upon rotation of said plunger housing.

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