July 26, 1960 C. E. SYLVANDER ET AL 2,946,290

FLUID DISTRIBUTION DEVICE

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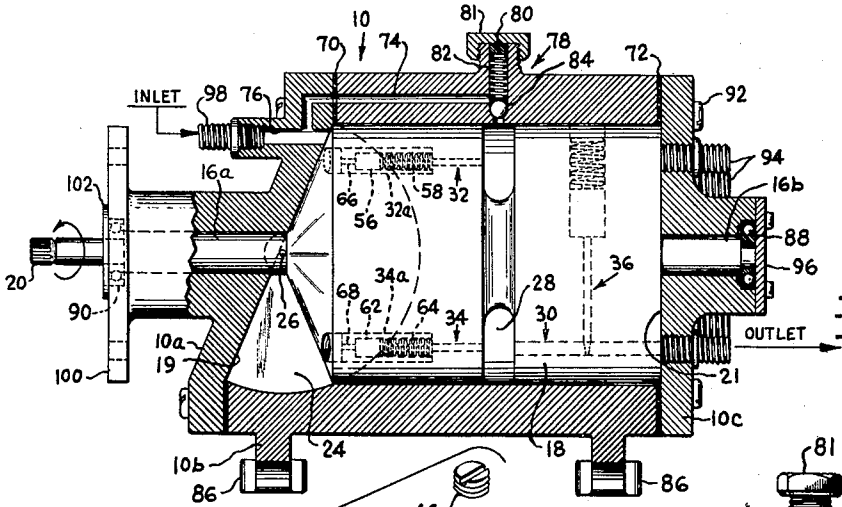


Fig. 1

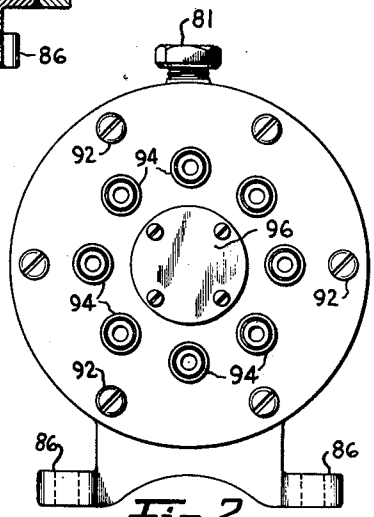


Fig. 2

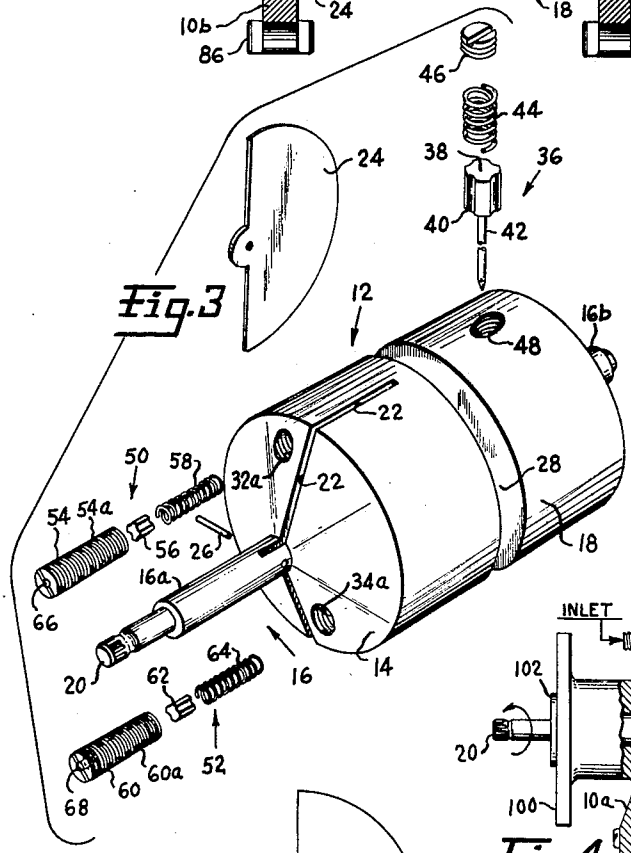


Fig. 3

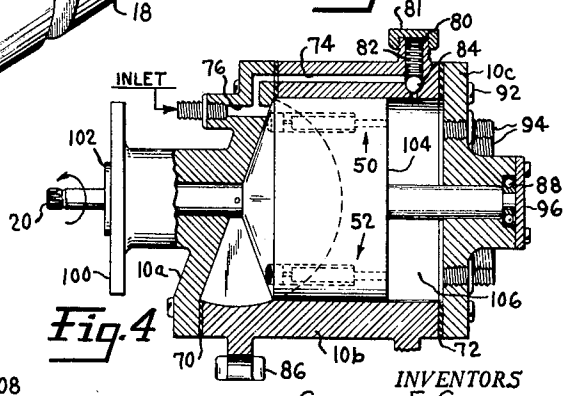


Fig. 4

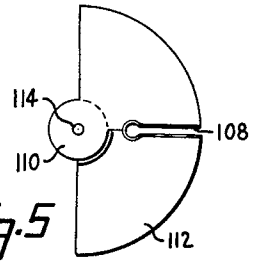


Fig. 5

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FLUID DISTRIBUTION DEVICE

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9 Claims. (Cl. 103—142)

This invention relates to an improved fluid distribution device, and more specifically to a device which is of particular applicability as a fuel injection pump.

In preferred form, the device comprises a stator member internally recessed to define a bore, the stator member having terminal faces at each end thereof. A rotor member, comprising a shaft and a main body element mounted thereon, is suitably supported for rotation within the bore. The main body element comprising an inclined surface portion at one end in the form of a truncated cone and a cylindrical portion, the circumference of the cylinder and the cone base being coincident, said cylindrical portion being in contiguous relation with the bore walls in rolling engagement thereto. One of the terminal faces of the stator is inclined to the rotor axis, and together with the inclined rotor surface it defines a chamber. Upon rotation of the rotor member, the inclined surface remains tangent to the inclined terminal face of the stator along a line so as to divide the chamber into respective fluid tight compartments for suction and exhaust. At least one oscillating plate member is arranged to extend into the chamber in a slot which extends through the shaft and the cylindrical portion in a plane which includes the rotor axis. The bore has a configuration adapted to contiguously engage the said plate member through 360° of revolution, the plate member being cyclically displaced within the slot upon rotation of the rotor member. A pair of fluid conduits are arranged within the rotor member, one on each side of a respective plate member. The fluid conduits include valve means which permit fluid flow in one direction only. Outlet means are arranged in fluid flow connection with the said fluid conduits. An inlet passage in the stator member communicates with the chamber and with the outlet means. Control means are interposed in the fluid path between the inlet passage and the outlet means, and upon rotation of the rotor member, fluid under pressure is supplied to the outlet means.

Accordingly, it is an object of this invention to provide an improved fluid distribution device which is simple in construction, and has a minimum of component parts, so that it may therefore be readily assembled and disassembled.

Another object is to provide an improved fluid distribution device which delivers fluid at a pressure which is a function of the speed of the rotor.

Another object is to provide an improved fluid distribution device in which the fluid is delivered in a smooth flow which is non-pulsating.

Still another object is to provide an improved fluid distribution device having a high volumetric efficiency over a wide range of rotational speeds.

The novel features which are believed to be characteristic of the invention are set forth with particularity in the appended claims. The invention itself, however, both as to its organization and method of operation, together with further objects and advantages thereof, may best be understood by reference to the following description when read in connection with the accompanying drawings in which:

Fig. 1 is a front plan view, of one illustrative embodiment of the improved fluid distribution device in accordance with the invention;

Fig. 2 is a right end view of the distribution device of Fig. 1;

Fig. 3 is an exploded perspective view of the rotor member proper of the fluid distribution device of Fig. 1, together with various cooperating components;

Fig. 4 is a front plan view of a second illustrative embodiment of the improved fluid distribution device in accordance with the invention, and

Fig. 5 is a top view of an alternate form of vane member for use with the improved fluid distribution device in accordance with the invention.

Referring now to the drawing, the improved fluid distribution device in accordance with the invention, comprises a stator member or housing indicated generally at **10** and a rotor indicated generally at **12**.

As best shown in Fig. 3, the rotor member comprises a main body element mounted on a shaft indicated generally at **16**, the shaft having ends **16***a* and **16***b*. The main body element comprises an inclined surface portion **14** at one end in the form of a truncated cone and a cylindrical body portion **18**, the circumference of the cylinder **18** and the cone base being coincident. The shaft end **16***a* is splined at **20**. The main body element **14** and the shaft end **16***a* are slotted as shown at **22**. An arcuate plate member or vane **24** is passed through the slot **22**, and secured to the shaft end **16***a* in any suitable manner such as by a ball bearing pressed into the shaft. In the interests of simplicity, in the drawing the vane **24** is shown secured to the shaft by means of a pin **26**. When thus positioned, the vane **24** is free to oscillate in a plane which includes the rotor axis. The main body element **14** is provided with an annular groove indicated at **28**, the groove extending radially inwardly for some distance.

A number of fluid conduits **30**, **32**, **34** running in a direction parallel with the rotor axis, and adapted to communicate with the annular groove **28** as may be seen from a study of Fig. 1.

A metering restriction means is indicated at **36**. This means comprises a main body **38** and a reduced diameter shaft **42** which is tapered at its lower end. The body portion **38** includes a number of peripheral longitudinal grooves **40**. The metering restriction means **36** is positioned within a suitably shaped recess in the rotor body, so that its lower tapered end is interposed in the conduit **30**. The metering restriction means **36** is resiliently mounted in this recess by means of a spring **44** and a plug **46** in the sequence shown in the exploded view of Fig. 3. The plug **46** is threaded so that it may be screwed into the threaded portion **48** of the aforementioned recess in the rotor. In this manner, the compression of the spring **44** may be varied in the degree desired.

A pair of valve means **50**, **52** are arranged one on each side of a respective oscillating vane **24**. Valve **50** comprises a threaded plug **54**, a slotted piston member **56** and a spring **58**. As may be seen in the drawing, plug **54** is slotted to enable it to be manually turned by means of a screw driver. The plug **54** is internally recessed at **54***a* to receive slotted piston **56** in sliding engagement; it includes an inlet opening **66** which communicates with the recess **54***a*.

The fluid conduit **32** includes an enlarged threaded portion **32***a* which is of such dimensions that plug **54** may be screwed therein.

When the check valve **50** is in the operating position (shown in Fig. 1) the spring **58** resiliently urges the piston **56** in the direction of the opening **66** and against

a suitable shoulder (unnumbered) formed in the recess 54*a*.

Similarly, valve 52 comprises threaded plug 60, splotted piston 62 and spring 64. The plug 60 is slotted to enable it to be turned by a screw driver, and includes an inlet opening 68 communicating with internally recessed 60*a*. The fluid conduit 34 includes an enlarged diameter portion 34*a* for receiving the plug 60.

The stator 10 comprises three casting members 10*a*, 10*b* and 10*c*. Shim gaskets 70, 72 are inserted between the castings 10*a* and 10*b* and 10*c* respectively.

The stator 10 includes an inlet passage. For convenience in fabrication, this inlet passage comprises two parts: inlet passage 74 in main casting member 10*b* which is arranged in register with a similar inlet passage 76 in casting member 10*a*. As may be seen from a study of Fig. 1, the passage 74 is also arranged so as to communicate with annular groove 28 in the rotor through the control means indicated generally at 78. The control means 78 is arranged in an enlarged diameter portion of the casting 10*b* and comprises a bronze bushing 80, a spring member 82 and a ball 84. The casting 10*b* includes mounting legs 86.

The rotor shaft end 16*b* is suitably mounted in casting member 10*c* by means of ball bearings 88. Similarly, the other rotor shaft end 16*a* is mounted for rotation in casting member 10*a* by means of ball bearings 90.

The casting 10*c* is secured to the main casting member 10*b* by means of a plurality of bolts 92 suitably arranged around the periphery. The casting 10*c* also includes a plurality of outlets which comprise pipe fitting members 94 screwed into the casting. A cover plate 96 is bolted to the casting as shown. This plate serves to keep dust from the bearing 88 and provides access thereto for purpose of lubrication.

The casting 10*a* includes a terminal face 19 which is inclined to the rotor axis. Thus, as may be seen from a study of the drawing, the inclined stator terminal face 19 and the inclined rotor surface 14 define a chamber. Upon rotation of the rotor member 14, the inclined surface 14 remains tangent to the stator face 19 along a line so as to divide the chamber into fluid tight compartments for suction and exhaust. Conduits 32 and 34 are the inlets for the annular groove 28 and are located the outlet sides of vane 24. The stator casting 10*c* has a terminal face 21, sufficient clearing of course being maintained between it and the end face of the rotor.

A screw pipe fitting member 98 is arranged in casting 10*a* so as to communicate with passage 76. The casting 10*a* includes a mounting plate 100 since the distributing device may be mounted by this means in some applications. Plate member 102 suitably secured to the casting provides dust protection and lubrication access for the other ball bearing 90.

In the second illustrative embodiment shown in Fig. 4, the same numeration has been retained to identify the members which are identical with those found in the embodiment described and illustrated in Figs. 1–3. In the embodiment shown in Fig. 4, a different rotor construction as been shown. In the rotor member 104, the annular groove 28 and the metering restricting means 36 have been eliminated. Instead, the rotor 104 is terminated short of the end face of casting 10*c*, thereby providing a chamber 106.

The stator housing may be of cast aluminum. The terminal faces 19 and 21 may be hardened steel discs mounted in the end casting members 10*a* and 10*c* respectively.

Operation

Referring now to Fig. 1, the inclined terminal face 19 and the inclined rotor surface 14 together define a chamber. Upon rotation of the rotor 12 the inclined surface 14 remains tangent to the terminal face 19 along a line so as to divide the chamber into fluid tight compartments for suction and exhaust. Fuel is supplied to the inlet passage 76. As the rotor member 12 rotates in the direction shown in the drawing, the vane 24 continously contacts the terminal face 19. The edge of the vane 24 which first passes the inlet passage 76 creates a suction behind it which continues until the second edge of the vane 24 passes the inlet 76. This suction is cut off by the partitioning action of the second edge of the vane which in turn begins its own suction which continues until the first edge of the vane completes its cycle, whereupon the process is repeated.

As the first edge of the vane moves down in its cycle, the space behind it increases in volume and it is this increase in volume which provides the suction. When the cycle is one-half completed, this volume is at its maximum, and at this moment the second edge of the vane (after terminating the suction) forces the fuel behind the first edge of the vane into a decreasing volume as the first edge of vane 24 completes its cycle at the line of contact defined by the tangency of the terminal face 19 and the inclined rotor surface 14.

As the volume between the vane edges decreases, the resulting increase in pressure causes the valve means 50, 52 to alternately unseat, so that fluid is forced through the slots in piston member 56, 62 respectively, and through the conduits 32, 34 to the annular groove 28. The valve means 50, 52 serve as check valves to insure one way passage of fluid to maintain a pressure flow through conduit 30.

In the embodiment of Figs. 1–2, this means fluid is forced into conduit 30 and through which every outlet fitting 94 is then or next in register with conduit 30. In the embodiment of Fig. 4, the fluid is forced directly into the storage chamber 106.

The metering restriction means 36 in fluid communication with conduit 30 is adjustable by means of screw plug 46 so as to permit variable amounts of fluid to pass to the outlet, the volumetric output depending, of course, upon the application. However, the metering restriction also serves an additional function—at high r.p.m. (when more fuel is needed) the slotted piston 38 is thrown toward the rim of the rotor by centrifugal action, and thus the tapered shaft 42 is withdrawn further from the conduit 30, so as to permit additional fluid to flow to the outlet fittings 94. Conversely, as the r.p.m. decrease, the spring 44 forces the tapered shaft 42 back into the conduit 30 decreasing the volume of fluid delivered. The grooves 40 prevent any hydraulic action which would tend to stop the free movement of the pin in the event of fluid seepage into the chamber which houses spring 44.

The ball 84 of the control means 78 rides in the passageway 74 closing or unclosing it as required. The purpose of the control valve 78 is to permit fluid to bypass from the peripheral groove 28 to the inlet passage 76 when the fluid conduit 30 is in between outlet fittings 94.

In those applications where the fluid distribution device is subjected to a continuous heavy duty cycle, it may be found that the plate member 24 will wear so that some slack will develop between the vane 24 and the terminal face 19. In order to meet this contingency there is provided a split type plate member or vane 112 shown in Fig. 5, which may be used in the fluid distribution device of this invention.

The vane 112 is segmented as shown in Fig. 5; spring means 108 are mounted along the edges of these segments as shown so as to resiliently urge the vane 112 into contiguous relation with the terminal face 19. Each of the segments has a corresponding configuration so that when in assembled position they provide a hub at 110. A bore 114 is provided to receive mounting pin 26 thereby defining a hinge; however, if it is preferred, the vane 112 may be mounted on the rotor shaft 16*a* by ball bearing means.

While specific embodiments have been shown and de-

scribed it will, of course, be understood that various other modifications may yet be devised by those skilled in the art which will embody the principles of the invention and found in the true spirit and scope thereof.

We claim:

1. A fluid distribution device of the type described comprising a stator member internally recessed to define a bore, said stator member comprising terminal faces at each end of the bore, a rotor member comprising a shaft and a main body element mounted thereon, said main body element comprising an inclined surface portion at one end in the form of a truncated cone and a cylindrical body portion, the respective circumferences of the cylinder and the cone base being coincident, said rotor shaft extending within and suitably supported for rotation within said bore, one of said terminal faces being inclined at an acute angle to the rotor axis, said cylindrical body portion being contiguous with the bore walls in rotational engagement therewith, said inclined stator terminal face and said truncated cone defining a chamber at one end of said device, said truncated cone upon rotation of the shaft being tangent to the said inclined terminal face of the stator member along a line so as to divide said chamber into respective fluid tight compartments for suction and exhaust, at least one oscillating plate member arranged to extend into the chamber respectively, said one oscillating plate member being mounted in a slot which extends through said shaft, and said cylindrical body portion in a plane which includes the rotor axis, said bore having an internal configuration adapted to contiguously engage said one oscillating plate member through 360° of shaft revolution, whereby the said one oscillating plate member is cyclically displaced within the slot upon shaft rotation, the rotor member comprising a pair of fluid conduits positioned therein, one on each side of said one oscillating plate member for receiving fluid under pressure from said chamber, valve means in said fluid conduits for permitting fluid flow in one direction only, the device having outlet port means connected with said fluid conduits, the stator having an inlet passage means and a bypass passage means, said inlet passage means connecting with said chamber and adapted for receiving fluid, said bypass passage means connecting with said inlet passage at one end thereof, the other end of said bypass passage means connecting with said outlet means to provide fluid bypass from the outlet means to said inlet passage means, control means interposed in the said bypass passage means between said inlet passage means and said outlet means for controlling the volume of the said fluid bypass, whereby upon rotation of the rotor member, fluid under pressure is delivered from the said chamber through one of said fluid conduits to the outlet port means.

2. A fluid distribution device according to claim 1 wherein said control means is a ball-spring valve, said ball spring valve yieldingly permitting fluid flow from the outlet means to the inlet passage when the fluid pressure at said outlet means exceeds a predetermined maximum.

3. A fluid distribution device according to claim 1 wherein said valve means is a check valve comprising a slotted piston member, a plug member having an opening and internally recessed to receive said slotted piston, and a spring member resiliently urging said piston in the direction of said opening.

4. A fluid distribution device of the type described, comprising a stator member internally recessed to define a bore, a rotor member having a shaft supported for rotation within said bore, said rotor and stator members in operating position defining a chamber having fluid tight compartments for suction and exhaust respectively, at one end of said device, at least one oscillating plate member arranged to extend into the chamber respectively, said one oscillating plate member being mounted in a slot which extends through said shaft, and said rotor member in a plane which includes the rotor axis, said bore having

an internal configuration adapted to contiguously engage said one oscillating plate member through 360° of shaft revolution, whereby the said one oscillating plate member is cyclically displaced within the slot upon shaft rotation, the rotor member having a pair of fluid conduits positioned within said rotor member one on each side of said one oscillating plate member, for receiving fluid under pressure from said chamber, valve means in said fluid conduits for permitting fluid flow in one direction only, the device including outlet port means connected with said fluid conduits, the stator member having an inlet passage means and a bypass passage means, said inlet passage means being adapted for receiving fluid, and for communicating with said chamber, said bypass passage means connecting with said inlet passage means at one end thereof, the other end of said bypass passage means connecting with said outlet port means to provide fluid bypass from the outlet means to said inlet passage means whereby upon rotation of the rotor shaft, fluid under pressure is delivered from the said chamber through one of said fluid conduits to said outlet port means.

5. A fluid distribution device of the type described, comprising a stator member internally recessed to define a bore, said stator member comprising terminal faces at each end of the bore, a rotor member comprising a shaft and a main body element mounted thereon, said main body element comprising an inclined surface portion at one end in the form of a truncated cone and a cylindrical body portion, the respective circumferences of the cylinder and the cone base being coincident, said rotor shaft extending within and suitably supported for rotation within said bore, one of said terminal faces being inclined at an acute angle to the rotor axis, said cylindrical body portion being contiguous with the bore walls in rotational engagement therewith, said inclined stator terminal face and said truncated cone defining a chamber at one end of said device, said truncated cone upon rotation of the shaft being tangent to the said inclined terminal face of the stator member along a line so as to divide said chamber into respective fluid tight compartments for suction and exhaust, at least one oscillating plate member arranged to extend into the chamber respectively, said one oscillating plate member being mounted in a slot which extends through said shaft and said cylindrical body portion in a plane which includes the rotor axis, said bore having an internal configuration adapted to contiguously engage said one oscillating plate member through 360° of shaft revolution, whereby the said one oscillating plate member is cyclically displaced within the slot upon shaft rotation, the rotor member having a pair of fluid conduits positioned within, one on each side of said one oscillating plate member, valve means in said fluid conduits for permitting fluid flow in one direction only, the stator member having an inlet passage means and a bypass passage means, said inlet passage means being adapted for receiving fluid, and for connection with said chamber, said bypass passage means connecting with said inlet passage means at one end thereof, the rotor member comprising an annular groove around the periphery of the cylindrical portion thereof, and adapted to connect with the other end of said bypass passage means and with said fluid conduit pair to provide fluid bypass from said annular groove to said inlet passage means, the rotor member also having a third fluid conduit means arranged therein and adapted to connect with said peripheral annular groove, and a plurality of outlet means arranged in a circular manner in the stator member whereby upon rotation of the rotor member, said third fluid conduit means successively registers with the several outlet means respectively, and control means interposed in the bypass passage means between said inlet passage means and said peripheral annular groove for controlling the volume of bypass fluid.

6. A fluid distribution device according to claim 5 in which a metering restriction means is arranged for dis-

placement within the rotor member, and adapted to variably restrict fluid flow in said third conduit.

7. A fluid distribution device according to claim 5 including a metering restriction means arranged in a recess in the rotor member and comprising a slotted piston member terminating in a tapered shaft, said tapered shaft extending into said third conduit to variably permit fluid flow therein.

8. A fluid distribution device according to claim 5 in which said plate member comprises two identical segments secured to said rotor shaft to define a hinge, and spring means secured to said segments in the plane thereof, for resiliently urging said segments in an arcuate path about said hinge.

9. A fluid distribution device of the type described comprising a stator member internally recessed to define a bore, said stator member comprising terminal faces at each end of the bore, a rotor member comprising a shaft and a main body element mounted thereon, said main body element comprising an inclined surface portion at one end in the form of a truncated cone and a cylindrical body portion, the respective circumferences of the cylinder and the cone base being coincident, said rotor shaft extending within and suitably supported for rotation within said bore, one of said terminal faces being inclined at an acute angle to the rotor axis, said cylindrical body portion being contiguous with the bore walls in rotational engagement therewith, said inclined stator terminal face and said truncated cone defining a chamber at one end of said device, said truncated cone upon rotation of the shaft being tangent to the said inclined terminal face of the stator member along a line so as to devide said chamber into respective fluid tight compartments for suction and exhaust, at least one oscillating plate member arranged to extend into the chamber respectively, said one oscillating plate member comprising two identical segments secured to said rotor shaft to define a hinge, and spring means secured to said segments in the plane thereof, for resiliently urging said segments in an arcuate path about said hinge, said one oscillating plate member being mounted in a slot which extends through said shaft, and said cylindrical body portion in a plane which includes the rotor axis, said bore having an internal configuration adapted to contiguously engage said one oscillating plate member through 360° of shaft revolution, whereby the said one oscillating plate member is cyclically displaced within the slot upon shaft rotation, the rotor member including a pair of fluid conduits positioned within said rotor member one on each side of said one oscillating respective plate member, valve means in said fluid conduits for permitting fluid flow in one direction only, the device having outlet means connected with said fluid conduits, the stator member having an inlet passage means and a bypass passage means, said inlet passage means adapted for receiving fluid, and for connection with said chamber, said bypass passage means connecting with said inlet passage means at one end thereof, the other end of said bypass passage means connecting with said outlet means, to provide fluid bypass from the outlet means to said inlet passage means, control means interposed in the bypass passage means between said inlet passage means and said outlet means for controlling the volume of bypass fluid, whereby upon rotation of the rotor shaft, fluid under pressure is delivered from said chamber through one of said fluid conduits to the outlet means.

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