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VARIABLE PRESSURE FLUID PUMP

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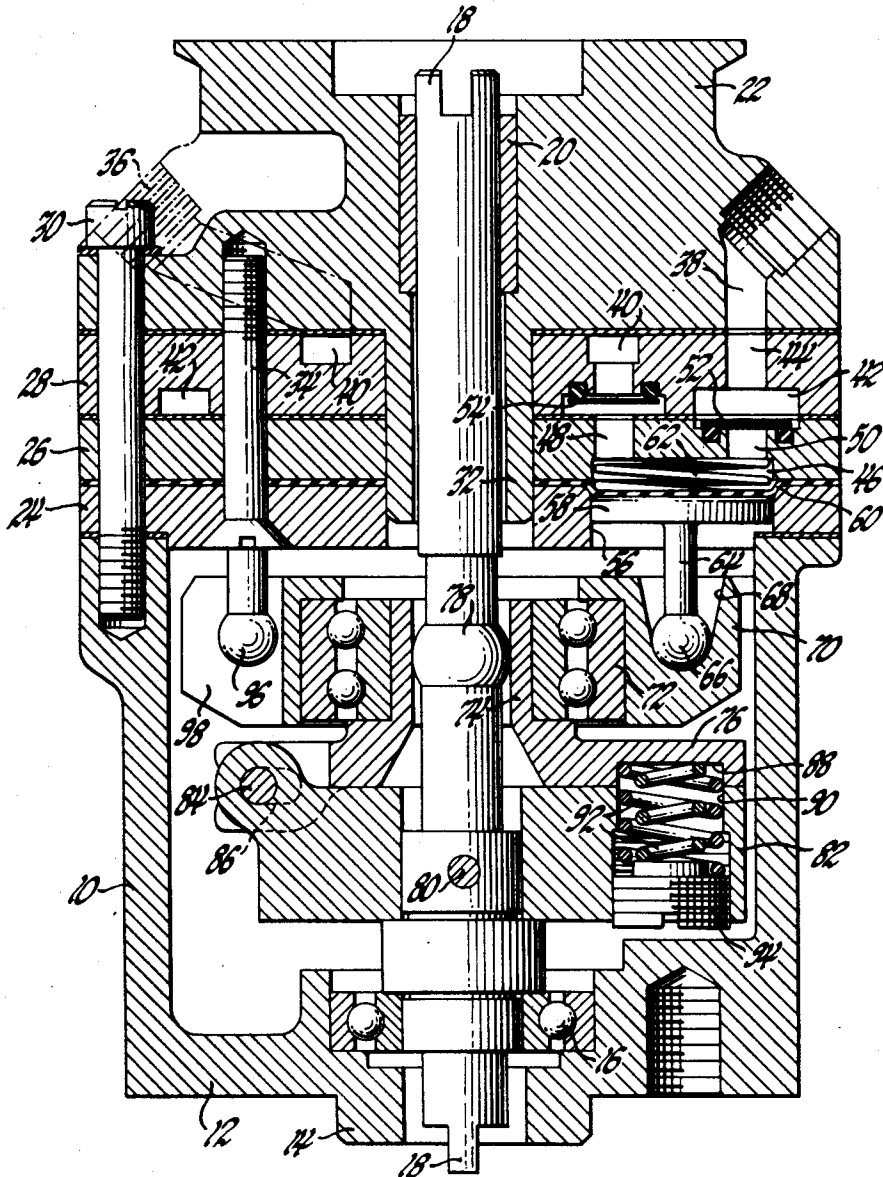


Fig. 1

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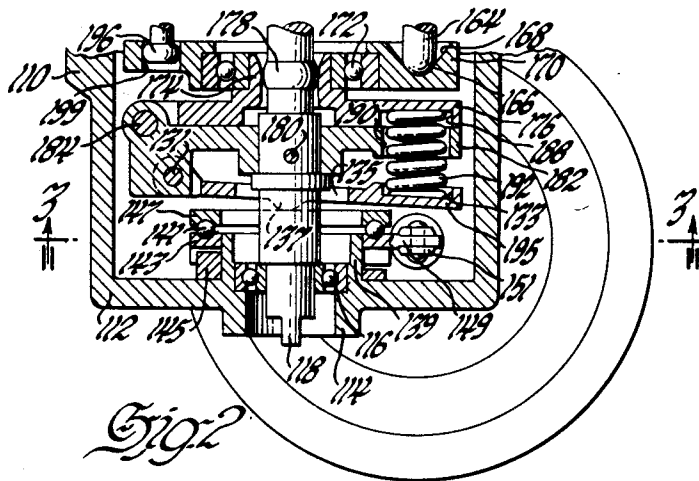
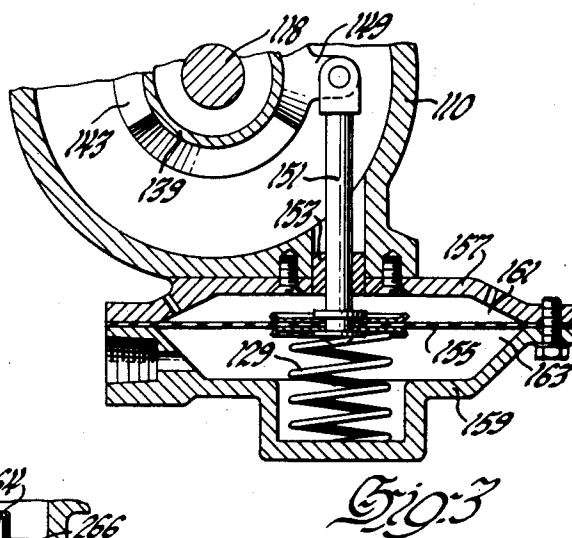
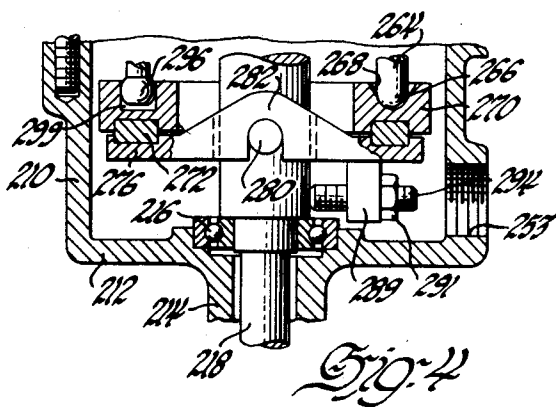
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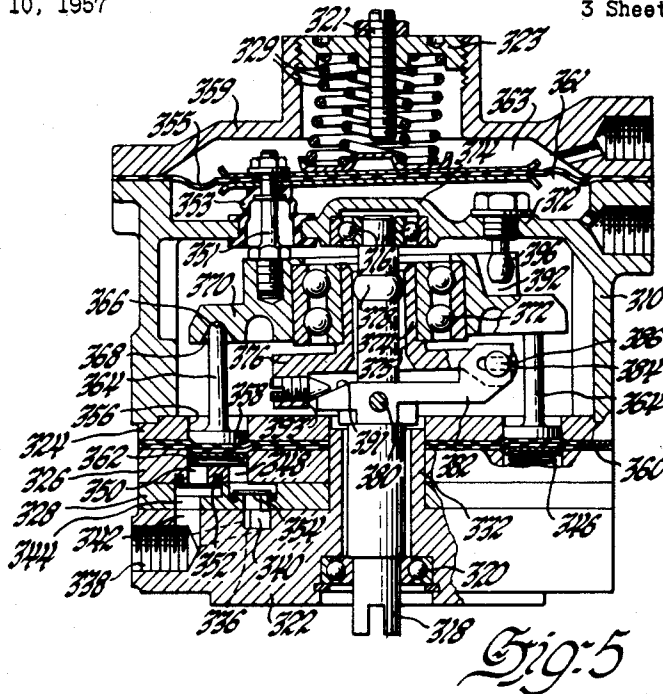
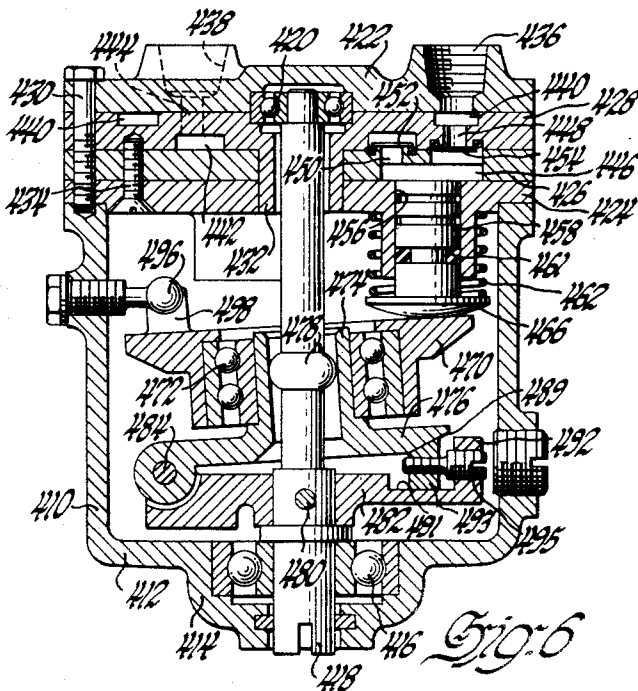
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VARIABLE PRESSURE FLUID PUMP

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VARIABLE PRESSURE FLUID PUMP

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The invention relates to a variable pressure fluid pump and more particularly to a pump of the wobble plate type. The pump with the various modifications disclosed is comprised of a plurality of plungers which are reciprocated by the action of a wobble plate and act upon either a common diaphragm or directly to produce a desired pressure in the fluid. Several arrangements for adjustment of the pump stroke are disclosed which provide minute adjustment.

Pumps of the type with which the invention is concerned are adapted for use in systems requiring a relatively constant source of fluid under a predetermined pressure. They can be accurately adjusted by adjusting the tilt angle of the wobble plate. In order to be used in high pressure sensitive systems such as automotive fuel injection systems however, pumps previously known have not obtained the high degree of accuracy of pressure control necessary. Such pumps must have a long life and be relatively free from mechanical failures while providing the high degree of accuracy required. The pumps herein disclosed which embody the invention are adapted to a long trouble-free life and may be very accurately controlled either by pre-set mechanisms or pressure controlled devices which are subject to the varying conditions in the associated equipment. The pumps may be used as fuel pumps for automotive engines and are also adapted to other uses requiring the features set out.

In the drawings:

Figure 1 shows a pump in cross-section and embodying the invention.

Figure 2 shows a modification of the pump pressure adjusting controls for the pump of Figure 1.

Figure 3 is a view taken in the direction of arrows 3—3 of Figure 2.

Figure 4 shows a second modification of the pump pressure adjusting controls for the pump of Figure 1.

Figure 5 shows a modified pump with pressure adjusting controls sensitive to operating conditions of the engine and having parts broken away and in section.

Figure 6 shows another pump modification with a modified form of mechanism for adjusting the pump pressure.

The pump shown in Figure 1 includes a housing 10 having integrally formed therewith an end plate 12 in which a hub 14 is centrally located. Bearing 16 is mounted within hub 14 and receives drive shaft 18 therein. Drive shaft 18 extends through the housing and into a bearing 20 which is secured in pump end cover 22. Intermediate housing 10 and cover 22 are a plurality of plates extending transversely of the pump housing. These plates include plunger guide plate 24, outlet valve and pressure chamber plate 26 and inlet valve and manifold chamber plate 28. A plurality of bolts 30 may be used to secure cover 22 and plates 24, 26 and 28 to the housing 10. In order to properly assemble the plates in relation to the remainder of the pump, cover 22 may be provided with an inwardly extending hub 32 on which the plates 24, 26 and 28 are piloted. A key or other suitable means

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may be used to permit assembly of the plates only when they are in proper alignment relative to each other and to the cover 22. Bolts 34 may be provided to fasten the plates to the cover in order to permit removal and assembly of the plate and cover group as a unit. The housing, plates and cover are preferably separated and sealed by gaskets positioned between adjacent elements.

Cover 22 may be provided with an inlet passage 36 and an outlet passage 38. Plate 28 may be provided with an annular manifold type inlet chamber 40 which is preferably formed as a groove in the upper side of the plate. When the plate 28 is assembled on the cover 22, the lower surface of the cover closes the groove and forms the chamber. Inlet passage 36 is aligned with the chamber 40. Plate 28 is also provided with an annular manifold type outlet chamber 42 which may be formed as a groove on the lower side of the plate. Chamber 42 is concentric with and larger in diameter than chamber 40. An outlet passage 44 connects chamber 42 with outlet passage 38.

Plate 26 is provided with a plurality of pressure chambers 46 and inlet passages 48 and an outlet passage 50 for each of the pressure chambers. Each of the outlet passages 50 is provided with an outlet valve 52 which is mounted in a recess formed in the upper side of plate 26. Each of the inlet passages 48 is provided with an inlet valve 54 which is mounted in recesses provided in the lower side of plate 28. The inlet and outlet valves may be of the check valve type.

The plunger guide plate 24 may be bored to form cylinders 56 which are adapted to receive pump plunger pistons 58. Each of the cylinders 56 are in alignment with an inlet passage 48 and an outlet passage 50 and a pressure chamber 46. The diaphragm 60 is preferably made of a material which operates satisfactory as a gasket between plate 24 and plate 26. Each portion of the diaphragm 60 which extends between the pressure chamber 46 and the cylinders 56 is adapted to be engaged on its lower side by pistons 58 and on its upper side by a diaphragm return spring 62. Diaphragm 60 is therefore reciprocated with a pumping action when pistons 58 are reciprocated within cylinders 56.

Each of the pistons 58 has a plunger arm 64 extending down from its lower surface and terminating in a rounded end 66. Individual sockets 68 are formed within an actuating ring 70 and are adapted to receive plunger ends 66. Ring 70 is preferably mounted on the outer race of a bearing 72 with the inner race of the bearing secured to a hub 74 extending around drive shaft 18 and integrally formed with an oscillating member 76. Drive shaft 18 has an enlarged spherical gland 78 formed at a position within hub 74. The gland 78 has a diameter which is greater than the diameter of shaft 18 at this point and is substantially equal to the internal diameter of hub 74. This construction will permit actuating ring 70 to be tilted about the axis of drive shaft 18 when oscillating member 76 is tilted about that shaft. An enlarged section of the drive shaft 18 is formed intermediate the point at which drive shaft 18 passes through hub 14 and the gland 78. A drive pin 80 extends through this section in a transverse direction. A driving member 82 is mounted on pin 80 and is driven by shaft 18 through that pin. Oscillating member 76 is hinged at one side of driving member 82 with a hinge pin 84. The portion of oscillating member 76 extending around hinge pin 84 is preferably provided with an elongated hinge slot 86 to permit a slight radial movement of the oscillating member when it is tilted. A spring aperture 90 may be formed through driving member 82 and one or more plunger control springs 92 may be mounted within the depression 88 and the aperture 90. The lower end of aperture 90 may be threaded to receive a spring tension control plug 94. Plug 94 may be adjusted to impress the desired tension on plunger control

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springs 92. The tension so impressed tilts oscillating member 76 about hinge pin 84 to a desired angle. Actuating ring 70, being mounted on the outer race of bearing 72, also tilts at the same angle to regulate the stroke of pistons 58 within cylinders 56 as the drive shaft is rotated. Since hinge pin 84 may move radially within slot 86, the pivot point for oscillating member 76 and actuating ring 70 is at the center of spherical gland 78.

The position of the tension control plug 94 is pre-set prior to assembly of the plate and cover group to the pump cover and the pump will have a stroke of the desired length. An access may be provided in end plate 12 to permit further adjustments without disassembling the pump if desired. As the pistons 58 reciprocate within cylinders 56, diaphragm 60 is reciprocated within the pressure chamber 46. On the down stroke, fluid is drawn through inlet passage 36 and annular manifold chamber 40. The inlet check valve 54 is opened and fluid flows through inlet passage 48 to the pressure chamber. On the up stroke of the piston and diaphragm, inlet valve 54 is closed and outlet valve 52 is opened, permitting the pressurized fluid to flow through outlet passage 50 to annular manifold chamber 42 and to be delivered to a desired point from outlet passage 38.

A pin 96 may be secured to the lower side of plate 24 in order to prevent the rotation of actuating ring 70. This pin may mesh with a pair of lugs 98 which are formed on actuating ring 70. Pin 96 will then prevent any rotary motion of actuating ring 70 in either direction.

A modification of the oscillating member adjusting mechanism is shown in Figures 2 and 3. Housing 110 is provided with an end plate 112 and an outwardly extending hub 114 in which a bearing 116 is mounted. Drive shaft 118 is rotatably mounted within bearing 116.

The pump pistons are actuated by plunger arms 164 which are provided with rounded ends 166 and received within sockets 168. These sockets are formed in a circumferentially spaced arrangement in the upper side of an actuating ring 170. The actuating ring 170 is mounted on the outer race of the bearing 172. The inner race of the bearing is secured about a hub 174 formed on and extending from the upper side of oscillating member 176. A spherical gland 178 is formed on drive shaft 118 and is positioned radially inward from hub 174. A drive pin 180 is provided in drive shaft 118 and is in driving engagement with driving member 182. Oscillating member 176 is secured to driving member 182 at one side by slotted hinge 184. A spring receiving depression 188 is formed in the lower side of oscillating member 176 and a spring aperture 190 extends through driving member 182 and is in alignment with depression 188. A plunger control spring 192 extends through aperture 190 and into depression 188. A spring tension control arm 195 is pivoted to the lower side of driving member 182 by hinge 131 and is provided with a spring receiving depression 133 in alignment with aperture 190. The end of plunger control spring 192 opposite the end received in recess 188 is received within depression 133. A pin 196 may be fastened to a non-rotating part of the pump and extend downwardly into a recess 199 formed within actuating ring 170. Pin 196 will then prevent the actuating ring from rotating.

Spring tension control arm 195 is provided with an enlarged aperture 135 through which drive shaft 118 extends. Arm 195 is also provided with a downwardly extending cam 137 on either side of aperture 135.

End plate 112 is provided with an inwardly extending hub 139 which may have an internal diameter approximately equal to the external diameter of the outer race of bearing 116. A thrust bearing 141 has its lower ring 143 piloted on the outer surface of hub 139 and may be rotated relative to that hub. A stationary cam 145 is concentric with hub 139 and positioned intermediate thrust bearing 141 and the inner surface of end plate 112. The upper surface of cam 145 is preferably formed as

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a three-pronged face cam. The lower surface of lower bearing ring 143 may also be provided with a three-pronged face cam which is complementary to the cam 145. The upper ring 147 of bearing 141 has its upper surface in engagement with tension control arm cams 137 at two points substantially in alignment with the central axis of the drive shaft 118.

The lower ring 143 has a control lever 149 extending radially therefrom to which is attached an actuating rod 151. Rod 151 may extend generally perpendicular to and be spaced from drive shaft 118. Rod 151 passes through a guide bushing 153 in housing 110 and is connected at its opposite end to a vacuum sensitive diaphragm 155. Diaphragm 155 separates a space formed by cover plates 157 and 159 into a pair of chambers 161 and 163. Chamber 161 is subject to atmospheric pressure while chamber 163 is subject to intake manifold vacuum. A spring 129 is provided within the vacuum chamber 163 to urge actuating diaphragm 155 in a direction toward chamber 161.

When there is no vacuum impressed upon diaphragm 155, actuating rod 151 has lower ring 143 positioned in a counterclockwise direction as viewed in Figure 3. Cam 145 and the cam formed on lower ring 143 permit thrust bearing 141 to be in a position on its axial movement line nearest control arm 195. As the vacuum in chamber 163 increases, actuating arm 151 is moved toward vacuum chamber 163, rotating lower ring 143 clockwise as seen in Figure 3. Thrust bearing 141 is permitted to move axially away from tension control arm 195 by means of the cam 145. Since the upper ring 147 of the thrust bearing is in engagement with the cams 137, tension control arm 195 is pivoted downwardly about hinge 131, decreasing the tension on spring 192. This decreased tension causes oscillating member 176 to tend to pivot about slotted hinge 184, resulting in a tilting action about spherical gland 178. Actuating ring 170 is then tilted to the same degree as oscillating member 176, decreasing the stroke of the plungers 164. When the vacuum in chamber 163 approaches atmospheric pressure due to increased speed or torque requirements on the engine, spring 129 moves rod 151 to rotate cam 143 counterclockwise, increasing the stroke of the plungers. The actuating mechanism may be modified to use the increased vacuum force to increase the plunger stroke length if desired.

Another modification of the oscillating member adjusting mechanism is illustrated in Figure 4. The housing 210 is provided with an end plate 212 and an outwardly extending hub 214 in which a bearing 216 is secured. Drive shaft 218 is rotatably mounted within bearing 216. Housing 210 is provided in one side with an access opening 253 which is normally plugged during operation of the pump. The plug may be removed to adjust the mechanism. The pump, which may be similar to the pump of Figure 1, is provided with plunger arms 264 having rounded ends 266 which are received within sockets 268. These sockets are circumferentially spaced in the upper surface of the actuating ring 270. The lower surface of ring 270 is provided with an annular depression in which is received a bearing 272. Immediately below the actuating ring 270 and in bearing engagement with bearing 272 is an oscillating member 276. Both the actuating ring 270 and the oscillating member 276 extend circumferentially around the drive shaft 218. A drive pivot pin 280 extends transversely through drive shaft 218 and is received within slots formed in the bridge portion 282 of oscillating member 276. This arrangement permits the oscillating member 276 to rotate about the pivot 280 and to be rotatably driven by that pivot. Actuating ring 270 is prevented from rotating relative to housing 210 by pin 296. This pin is secured to the housing and received within recess 299 formed within the upper surface of ring 270.

The lower side of oscillating member 276 is provided with a depending lug 289 which threadably receives an ad-

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justing screw 294. Screw 294 extends radially towards drive shaft 218 and is in engagement with the outer surface of that shaft intermediate drive pivot 280 and bearing 216. A lock nut 291 may be provided to lock the adjusting screw 294 in the desired position relative to lug 289. Adjusting screw 294 may be screwed inwardly or outwardly to arcuately position lug 289 relative to drive shaft 218. Since lug 289 is attached to the oscillating member 276, the adjustment obtained through screw 294 tilts member 276 to the desired angle. Actuating ring 270 is also tilted to the same degree, adjusting the stroke of the plunger arms 264 to obtain the desired pressure.

A modified pump and adjusting mechanism is shown in Figure 5. The pump has the actuating pistons concentrically disposed in relation to the manual tilt adjusting mechanism. The actuating ring is rigidly attached to a vacuum sensitive diaphragm which provides the vacuum sensitive adjustment of the stroke of the pump pistons.

The pump of Figure 5 includes a housing 310 with which a web 312 is integrally formed. A bearing hub 314 is located centrally within web 312. A bearing 316 is received within hub 314 and provides a rotatable mount and end locating point for the end of drive shaft 318. A pump cover 322 is provided through which drive shaft 318 extends and bearing 320 is located in the pump cover 322 to provide a rotatable mount for the drive shaft. Intermediate the housing 310 and the pump cover 322 are several stacked plates which may be separated by gaskets. These plates include the plunger guide plate 324, the pressure chamber plate 326 and the valve plate 328. Pump cover 322 may have an inwardly extending hub 332 on which plates 324, 326, and 328 are piloted. An inlet passage 336 may be provided in pump cover 322 to enable the fluid being pumped to enter. An outlet access passage 338 may also be provided in pump cover 322 for delivery of the fluid from the pump. Pump cover 322 has formed within its upper surface an annular inlet manifold chamber 340. Individual outlet manifold chambers 342 may be provided concentrically outward from inlet manifold chamber 340. Outlet passages 344 connect each of the pressure chambers 346 with an outlet manifold chamber 342. Inlet passages 348 connect each of the pressure chambers 346 with inlet manifold chamber 340. Inlet valve 354, which may be of the check valve type, is mounted in between inlet passage 348 and manifold chamber 340 and may be located within plate 328. Outlet valve 352, which may also be of the check valve type, is located between outlet passage 350 and outlet passage 344 and occupies a recess provided in plate 328. Plate 324 has a plurality of cylinders 356 formed therein which are complementary to pressure chambers 346 in plates 326. Cylinders 356 and chambers 346 are separated by a pump diaphragm 360 which is mounted between plates 324 and 326. The diaphragm acts as a gasket between these plates and the portions of the diaphragm which are exposed to the pressure chambers 346 act as pump diaphragms. Pump plunger pistons 358 are reciprocally received within cylinders 356 and engage diaphragm 360 at their outer ends. A diaphragm return spring 362 may be provided in each of the pressure chambers 346. Pistons 358 may be integrally formed with plunger arms 364 which terminate at their ends opposite the pistons in rounded ends 366. Sockets 368 are formed within actuating rings 370 and receive the ends 366 of the plunger arms. Actuating ring 370 is preferably mounted on the outer race of the bearing 372. The inner race of bearing 372 is secured to hub 374 which extends around and is radially spaced from drive shaft 18. Hub 374 is integrally formed with an oscillating member 376. At a point within hub 374 drive shaft 318 is provided with an enlarged spherical gland 378 which has a diameter substantially equal with the diameter of oversized hub passage 375. Actuating ring 370 may be tilted about the axis of drive shaft 18 by arcuate movement of hub 374 about gland 378.

An enlarged section of the drive shaft has a drive pin

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380 extending transversely therethrough at a point intermediate the place where drive shaft 318 passes through hub 332 and the position of gland 378. Driving member 382 may be press fitted on drive shaft 318 and secured thereto by drive pin 380. Oscillating member 376 is hinged at one side of driving member 382 by means of a slidable hinge 384. Driving member 382 is provided with a hinge slot 386 which permits hinge 384 to slide radially when the oscillating member is tilted. Actuating ring 370 may be prevented from rotational movement with respect to housing 310 by pin 396 which extends downwardly from web 312 and engages ring 370 in recess 392.

An initial manual adjustment of the oscillating member 376 may be made by screwing tapered adjusting screw 393 inwardly or outwardly in the threaded depending lug attached to the lower side of member 376. The tapered end of screw 393 may contact bevel surface 391 which is formed on the side of driving member 382 adjacent screw 393. When screw 393 is moved inwardly, the angle between oscillating member 376 and drive member 382 is increased.

The pump of Figure 5 may be controlled during engine operation by intake manifold vacuum. A vacuum sensitive diaphragm 355 is provided for this purpose. Cover plate 359 may be suitably secured to pump housing 310 so that web 312 and the cover plate form a space divided by diaphragm 355 to define atmospheric chamber 361 and vacuum chamber 363. One or more springs 329 may be mounted between cover 359 and diaphragm 355 to resist movement of the diaphragm when vacuum is increased therein and to return the diaphragm to its neutral position when the vacuum approaches atmospheric pressure. The springs 329 may be adjusted by an adjustable spring retainer 323 which may be threaded into the cover plate 359. A stroke limiting screw 321 may be threaded through retainer 323 to provide a maximum stroke limiting position for diaphragm 355. Control arm 351 may be rigidly attached to diaphragm 355 and extend in a generally perpendicular direction from the diaphragm. The opposite end of arm 351 may be threaded into or otherwise fixedly attached to actuating ring 370. A bellows seal 353 may be secured in the aperture in web 312 through which arm 351 extends. Seal 353 allows longitudinal movement of arm 351 while effectively sealing atmospheric chamber 361 from the interior of the pump. When diaphragm 355 is moved under the influence of increased vacuum in chamber 363, arm 351 is moved in a direction generally parallel to drive shaft 318 and actuating ring 370 is pivoted about spherical gland 378. The tilt of ring 370 therefore depends upon the speed and torque requirements of the engine which are sensed by engine intake manifold vacuum.

The modified pump and adjusting mechanism shown in Figure 6 does not require the use of a pump diaphragm nor a vacuum control system. The pump housing 410 includes an end plate 412 in which an outwardly extending hub 414 is formed to receive bearing 416. Drive shaft 418 extends through hub 414 and is rotatably supported by bearing 416. The other end of drive shaft 418 is supported in bearing 420 which is secured in a depression formed in pump cover 422. Cover 422 may be secured to pump housing 410 by any suitable means such as bolts 430. A plunger guide plate 424, an inlet valve and pressure chamber plate 426 and an outlet valve and manifold chamber plate 428 are positioned between cover 422 and housing 410. Bolts 434 may be provided to secure plates 424 and 426 to plate 428. Plate 428 is provided with an inwardly extending hub 432 on which plates 424 and 426 are piloted.

Cover 422 may have an inlet access passage 436 and an outlet access passage 438 formed therein. Plate 428 may have an annular inlet manifold chamber 440 formed in its upper side and an annular outlet manifold chamber formed in its lower side. These chambers are preferably concentric with the axis of plate 428 and of different di-

ameters. An outlet passage 444 may connect passage 438 with chamber 442. Inlet passage 443 may be formed in plate 428 and connect chamber 440 with the pump pressure chambers 446. An inlet valve 454 may be located within the pressure chamber 446 adjacent passage 448. An outlet passage 450 may be provided in plate 426 to connect chamber 442 with pressure chamber 446 and may be controlled by an outlet valve 452. Plate 424 may have a plurality of bosses extending downwardly therefrom in which pump cylinders 456 are formed. A pump plunger piston 458 may be mounted for reciprocable movement within each of the chambers 456. A piston ring 461 may be provided to seal the pressure chambers from the interior of the pump housing. A piston return spring 462 may abut plate 424 and surround the bosses through which cylinders 456 are formed. The other end of springs 462 may abut the upper side of enlarged arcuate contacting ends 466 of the pump plunger 458. The arcuate surface of ends 466 are in engagement with actuating ring 470 and are reciprocated by the wobble plate movement of that ring. Ring 470 is secured to the outer race of bearing 472. The inner race of that bearing is secured to hub 474 which is formed on oscillating member 476. A spherical gland 478 is formed on shaft 418 and is of sufficient diameter to engage the internal surface of hub 474. The enlarged diameter of this gland permits oscillating movement of member 476. Drive shaft 418 is provided with a transversely extending drive pin 480 at a point intermediate gland 478 and bearing 416. A drive member 482 is mounted for pivotal movement on this pin and is driven rotatably by the pin when drive shaft 418 is rotated. Oscillating member 476 is pivoted to one side of drive member 482 by slidable hinge 484. The upper surface of drive member 482 which is opposite hinge 484 may be provided with a flat surface 491 and a threaded lug 492 adjacent the flat surface and generally perpendicular thereto. A differential thread adjusting screw 495 may be threaded in the lug 492 and terminate in an adjusting wedge 493. The upper surface of wedge 493 may be beveled and be complementary to the bevel surface 489 formed on oscillating member 476. When adjusting screw 495 is turned, web 493 moves radially inward or outward to increase or decrease the angle formed between drive member 482 and oscillating member 476. The change in this angle causes a commensurate change in the tilt angle of actuating ring 470. The strokes of the pistons 458 are adjusted by changing the tilt angle of ring 470 to adjust the output pressure of the pump. Actuating ring 470 is prevented from rotation relative to housing 410 by a pin 496 which is attached to the housing. Pin 496 extends inwardly to engage a pair of lugs 498 which are formed on the upper side of ring 470.

The pumps and pump stroke adjusting mechanisms which are the subject of the invention provide for a constant delivery of a fluid under a predetermined pressure which may be preset or controlled by operating conditions of associated mechanisms such as an internal combustion engine.

What is claimed is:

1. A vacuum controlled variable pressure pump having a tiltable actuating ring and reciprocable pistons driven by said ring, a chamber formed in one end of said pump and having a diaphragm extending therethrough, one side of said diaphragm being sensitive to vacuum induced by a vacuum source, an arm rigidly secured to said diaphragm and to said tiltable actuating ring whereby said actuating ring is tilted by movement of said diaphragm when said vacuum is modified, said tiltable actuating ring having a manually adjustable tilt control for initially adjusting the tilt of said actuating ring, said tilt control including a tapered adjusting screw and a beveled driving member cooperating with said screw to introduce a tilt angle to said actuating ring.

2. The mechanism of claim 1, said pistons being concentrically spaced about said manually adjustable tilt control.

3. A differential pressure controlled variable pressure pump having a tiltable actuating ring and reciprocable pistons driven by said ring, a chamber formed in one end of said pump and having a diaphragm extending therethrough, one side of said diaphragm being sensitive to a pressure induced by a pressure source, an arm rigidly secured to said diaphragm and to said tiltable actuating ring whereby said actuating ring is tilted by movement of said diaphragm when said pressure is modified, said tiltable actuating ring having a manually adjustable tilt control for initially adjusting the tilt of said actuating ring, said tilt control including a tapered adjusting screw and a beveled driving member cooperating with said screw to introduce a tilt angle to said actuating ring.

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