Oct. 8, 1935. E. BENEDEK 2,016,812

PUMP

Filed March 21, 1932 2 Sheets-Sheet 1

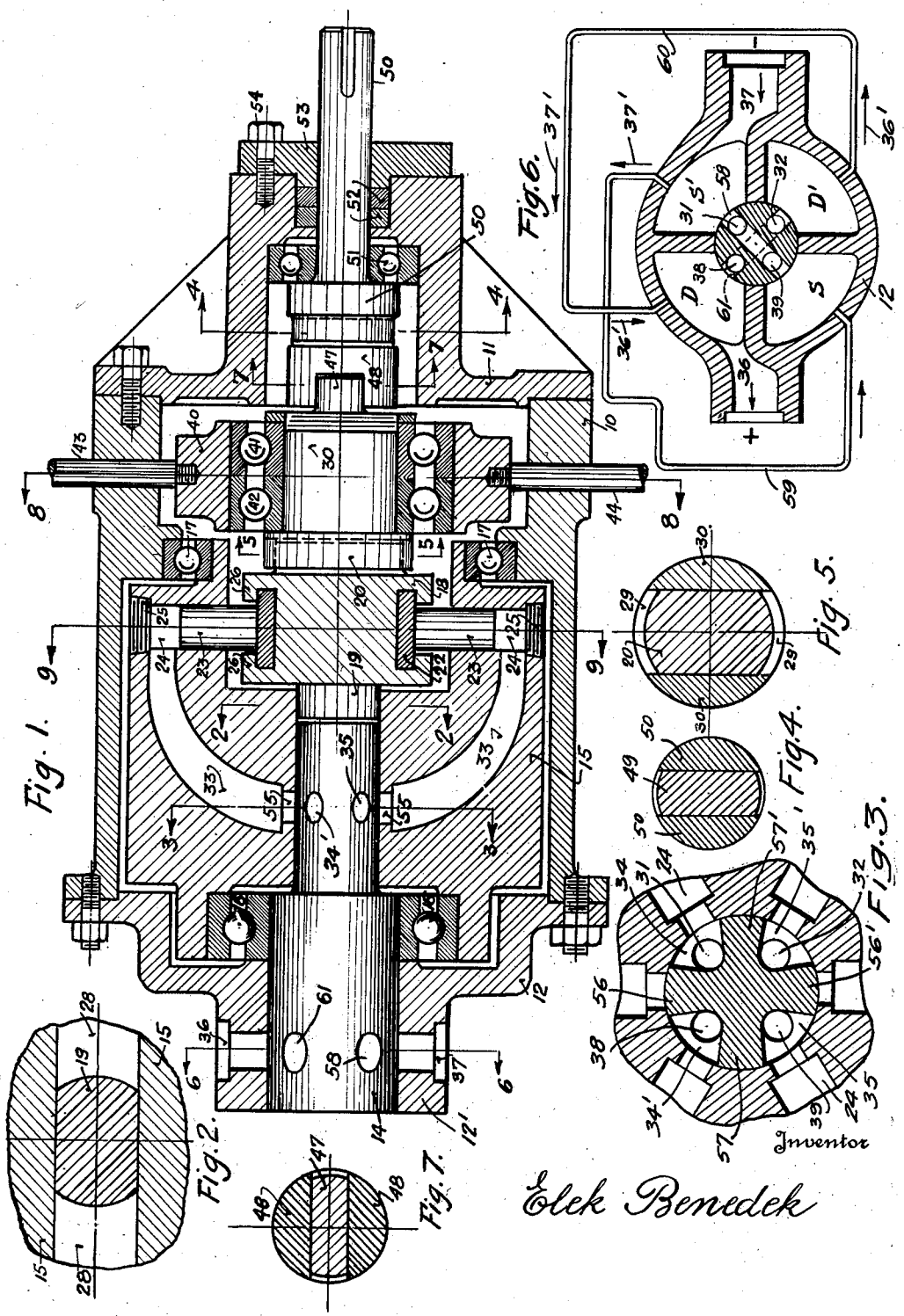

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

Fig. 5.

Fig. 6.

Fig. 7.

Inventor

Elek Benedek

Oct. 8, 1935. E. BENEDEK 2,016,812

PUMP

Filed March 21, 1932 2 Sheets-Sheet 2

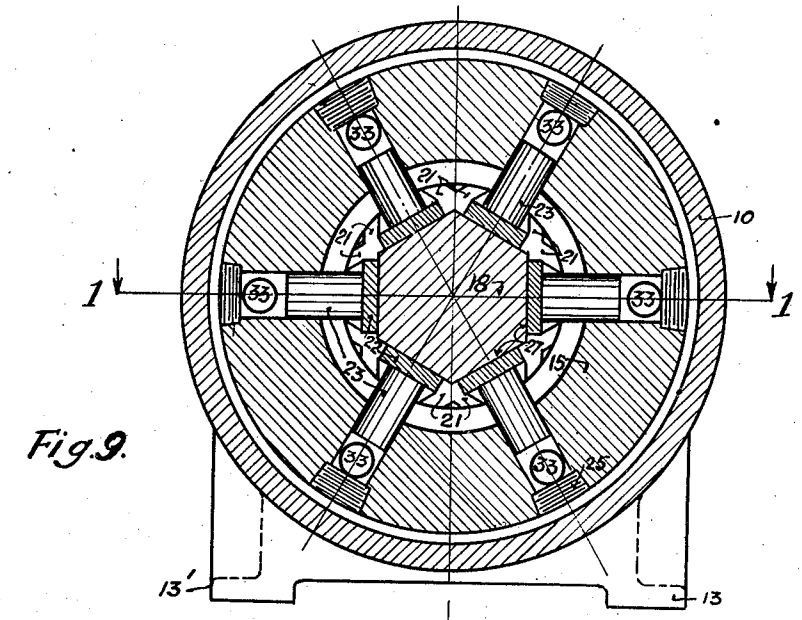

Fig. 9.

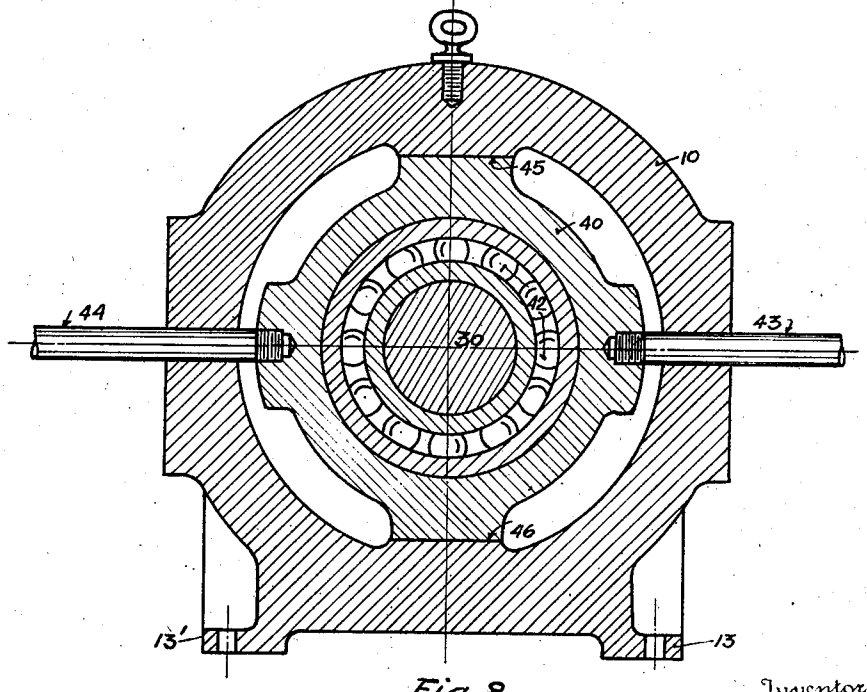

Fig. 8.

Inventor

Elek Benedek

Witness:
M. Mittag.
Don E. Youngblood.

Patented Oct. 8, 1935 2,016,812

UNITED STATES PATENT OFFICE

2,016,812

PUMP

Elek Benedek, Mount Gilead, Ohio

Application March 21, 1932, Serial No. 600,190

15 Claims. (Cl. 103—161)

This invention relates to variable delivery pumps and motors of the internally driven rotary piston type for use primarily in high pressure fluid transmission systems.

Pumps and motors of the type herein above referred to include ordinarily a variable stroke mechanism comprising a stationary eccentric shaft made by an outer eccentric member and an inner eccentric member, and the outer eccentric member is provided with mechanism whereby its angular position on the inner eccentric member can be varied to thereby vary the stroke of the pistons in the cylinders, the pistons having connecting rods bearing on the periphery of the outer eccentric member.

The purpose of the present invention is to simplify the variable stroke mechanism and provide a single rotary member thereof. The elimination of the connecting rods between the eccentric member and pistons will provide a novel connection between the rotary member or planetary eccentric and the associated pistons, in which the direction of each hydraulic piston load will coincide with the axis of the reciprocation of the piston and eliminates the wear on the cooperative surfaces of piston and cylinder assembly, and thereby increases the efficiency of the pump or motor.

According to the spirit of this invention a single rotary planetary eccentric is used for the drive of the pistons. Universal coupling means are used between the planetary eccentric and the impeller shaft to allow transverse shift of the planetary eccentric member. The pump and motor may have the same construction, however the eccentricity of the motor is ordinarily constant and this eliminates the stroke adjusting mechanism from the motor.

The pistons are of the crankless T-head type, provided with a tangential crosshead rigidly connected to the piston proper to operate the piston in radially in and out directions.

Another novel feature of this invention consists of the provision of a pump casing having a cylindrical opening at one end and a pair of tangential parallel shoulders at the other end to engage rigidly a slidable stroke controlling block.

The torque transmitting members between impeller and adjustable rotary member have pure harmonic oscillation relative to their cooperative members during rotation.

Further novelty of present pump or motor lies in the fact that during the operation of the pump the planetary eccentric is in perfect balance, including the cooperative pistons. This is evident for the zero delivery position when the whole rotary system rotates around the geometrical axis of the pump, at which time all the rotary parts are in perfect balance. It will be seen that during stroke periods of the pump the radial system of pistons will effect the perfect dynamic balance also of the planetary eccentric by getting the crossheads more crowded at one side of the eccentric than at the other.

Another object of my invention is to provide a planetating piston actuating means, whereby each piston will have two pressure and two suction strokes during each revolution and thereby to effect hydrostatically balanced load conditions in the barrel and its double acting cylindrical valve member or pintle, whereby to unload the bearings of the barrel and eliminate seizure between pintle and barrel.

The invention is more specifically described in connection with the attached drawings which show one form of the inventive idea.

In the acompanying drawings:

Figure 1 is a longitudinal horizontal sectional view of a pump constructed in accordance with present invention. This view is taken on the horizontal main axis of the pump, on line 1—1 in Fig. 9.

Figure 2 is a transverse sectional view taken on line 2—2 in Figure 1.

Figure 3 is a transverse sectional view taken on line 3—3 in Figure 1.

Figure 4 is a transverse sectional view taken on line 4—4 in Figure 1.

Figure 5 is a transverse sectional view taken on line 5—5 in Figure 1.

Figure 6 is a transverse sectional view taken on line 6—6 in Figure 1.

Figure 7 is a vertical cross section taken on line 7—7 in Figure 1.

Figure 8 is a vertical cross section taken on line 8—8 in Figure 1.

Figure 9 is a vertical cross section taken on line 9—9 in Figure 1.

The pump shown in the drawings is enclosed within a housing comprising a hollow cylindrical case 10, closed at its ends by end covers 11 and 12 respectively. The parts of the housing constitute a liquid tight reservoir with foot portions 13 and 13' for the mounting of the pump on a suitable bed plate.

The stationary distributor or pintle 14 is rigidly secured in the hub portion 12' of end cover 12 and projects inwardly into the casing to engage a rotary cylinder barrel 15 supported at its ends on anti-friction bearings 16 and 17, with the view

to center the barrel with respect to the pintle, and eliminate wear and metallic friction therebetween and provide a continuous capillary oil film also. Planetary eccentric 18 has two flattened end portions as at 19 and 20 respectively which are set at 90 degree position with respect to each other. A plurality of tangential grooveways 21 are provided to receive the associated crossheads 22 of piston 23. The pistons are fitted for radial reciprocation in their associated cylinders 24, and are removable through radial pipe plugs 25. The planetary eccentric 18 has a plurality of peripheral T-slots 21 with lip portions 26 to effect the suction stroke of the pistons whereas the pressure stroke is effected by the tangential reaction surfaces 27, the bottom surface of the T-slots 21. End portion 19 of the planetary eccentric 18 is fitted in the slotted portion 28 of the cylinder barrel 15 for sliding reciprocation as shown in Fig. 2 supported on oil film or on proper anti-friction bearings. The slotted groove-way 26 of the cylinder barrel cooperates with the slotted groove-way 29 of a rotary adjustable member 30, and they are set 90 degrees apart in regard to each other as illustrated in Fig. 1 and transverse sections of Fig. 2 and Fig. 5 respectively. Cylinders 24 are in communication alternatively during their rotation with distributor ports 34, 34', 35 and 35' respectively as shown in Fig. 3. Centrifugal channels 33 lead into the cylinders 24 which are in communication with suction and or delivery passages 31, 32, 38 and 39 respectively.

Referring to Fig. 6 it will be seen that each pump port 34, 34', 35 and 35' is in axial communication with a corresponding valve end head port as shown in the figure, S', D, S, D' respectively through axial passages 31, 38 and 39, 32 respectively.

With further reference to the figure, the diametrically opposite ports in the head 12 are in communication with each other as indicated in the figure through appropriate pipings. The flow of fluid between one set of ports of S and S' respectively is shown and the direction is indicated by the arrows 37' whereas the similar connection between the delivery ports D and D', is shown as at the arrows 36'. The main inlet and outlet reversible ports or pump mains 36 and 37 provide inlets and outlets for aforesaid S, S' and D, D' chambers respectively. The outside oil circuit is connected to said pump mains by heavy pipe flanges in a well known manner.

With reference to Fig. 3 it is evident that in ports 34 and 35 or 34' and 35', there is the same pressure at the same time, pressure or suction respectively, and therefore the rotor 15 and its bearings 16 and 17 will be unloaded with respect to hydrostatic pressure.

Rotary member 30 is mounted in bearing ring 40 on antifriction bearings 41 and 42 respectively and bearing ring 40 is attached to control rods 43 and 44 for lateral adjustment. Bearing ring 40 is furthermore slidably supported on a pair of opposed parallel bearing surfaces 45 and 46 respectively in the casing 10. There is an axial clearance between the members 14 and 18 to provide for the axial misalignment of the planetary eccentric and the pintle. Rotary member 30 furthermore has an axially extending flat portion 47 for radial reciprocation in the cooperative floating member 48 and for the transmission of the torque of the concentric impeller shaft 50 through the axially extending flat portion 49 of the floating member 48 as shown in Figs. 4 and 7 respectively. Impeller shaft 50 is supported on anti-friction bearing 51 and packed against leakage by packing rings 52 and packing gland 53 which latter is fastened to end cover 11 by cap screws 54.

In Fig. 1 anti-friction bearing 16 may be directly mounted on end cover 12, instead of on the enlarged portion of the distributor 14 which is supported by end cover 12.

As previously pointed out when rotary member 30 is adjusted laterally in eccentric position in regard to the center line of the rotating cylinder barrel, the pistons will resume reciprocation in their cylinders, due to the characteristic motion of member 18.

It follows from the foregoing analysis that since the planetary eccentric 18 is fully balanced, it will operate in a distinct and different manner with respect to the control member 30, than any piston actuating member heretofore known in variable delivery pumps. Since the rotor 18 is unloaded, its supporting end flats are also unloaded. This is particularly important for the control member 30, since it is supported in bearing means such as 41 and 42, which have substantially very short span, consequently an unbalanced load at the left end thereof by flat 20 as shown in Fig. 5 would impose considerable transverse load therein, which would result in sudden wear, or too expensive bearing structure for the support of member 30. It is further evident that the balanced performance of the control member 30 will allow balanced operation for the adjacent coupling member 48 and the driveshaft 50 respectively, so that these last named members will transmit only driving torque, and will be free of any lateral or transverse bending stresses which is not true in pumps of present commercial design as hereinabove referred to. The novel working method of my planetary piston actuating means 18, thus further results in any easy shift of member 40, the bearing housing of the stroke control mechanism, since there is no transverse force which would act in the bearings 41 and 42 and between their housing 40, and control means 30.

The individual cylinder and piston assemblies on the pressure sides will be under the hydraulic load of the fluid. Piston crossheads 22 will take up at all times the entire piston load, the crosshead and crosshead way being always perpendicular to the direction of reciprocation. This advantage of the crankless piston construction is increased by the fact that virtually all the driving of the cylinder barrel is effected mechanically by the flat portion 19 of the rotary eccentric 18 instead of by the piston units themselves.

The fluid capacity in passages 33 provides compressibility for the pistons in their outer dead centers at the end of the compression cycle, when cylinder ports 55 are blocked off for a certain length of time, by the positive laps of the bridges 56, 56', 57 and 57' respectively, as shown in Fig. 3, wherein the cylinder ports 55 are considerably smaller than the length of the bridges.

Further purpose of passages 33 connecting the outer ends of the individual cylinders 24 is in the provision of positive centrifugal pressure for the super-charging of the cylinders during the suction stroke. This condition provides a better filling of the cylinders and a greater volume of pump delivery which means higher efficiency of the pump and more silent operation thereof. Although an even number of pistons are shown in the drawings for the simplicty of illustration, any other number of pistons may be used according to the requirement of the duty for which the de-

vice is designed. Each piston will carry out a pure harmonic motion during its strokes. It is well known that the combination of uneven number of pistons will deliver smoother current than the combination of next greater number of pistons. For this well known reason, where a uniform stream of pressure fluid is required, ordinarily the minimum number of piston and cylinder assembly comprises five units.

In order to increase the efficiency of the relatively sliding members in the pump, various provisions may be made to retain a certain amount of the slip for useful lubrication. Although such provisions are not shown in the drawings, it is understood for instance that the counter-bored end portion of the cylinder barrel which surrounds the eccentric may be provided with an end ring in abutment with the barrel end 15, so as to retain a certain amount of slip past the several pistons to keep the crossheads flooded in centrifugal pressure oil. Similar provision may be made to close the inner end of the counterbore of the shaft end cover 11 in abutment with its inner face to flood the sliding joints of the shaft extension members with oil. The case 10, however, will be drained to avoid viscous friction on the rotating barrel and the churning up of oil.

The operation of the pump is as follows: Impeller shaft 50 will be driven by a suitable power such as an electric motor, Diesel engine or alike. As previously described the right hand support flat 20 of the planetary eccentric 18 is engaged slidingly in the slot 29 of the adjustable relative eccentric 30, whereas the left hand support flat 19 is guided in the slot 28 of the rotary barrel 15, thus the two end flats of the planetary eccentric are supported and driven between or by two parallel but axially off set members 15 and 30 respectively, and forming with them the floating member of the well known Oldham coupling. Therefore, so far as all the three members 15, 18 and 30 do rotate about a common axis such as the axis of the pintle 14, or the rotational axis of the impeller shaft 50, said three members will have a bodily rotation and no planetating takes place between the driving 30 and driven 15 coupling members. As soon as, however, the end members 15 and 30 will be set to an axially off set position, which is done here by the shifting of the bearing housing 40 through its control rods 43 and 44 respectively in either direction, the planetary eccentric will begin to planetate and an average point of its periphery will describe an oval shape path in the space, which path is known as the curve of Pascal or Pascal Limacon. Therefore, it is evident, that each crosshead 22 being driven and actuated by a slot 21 of the planetary eccentric will have two approaches and two retreats during each revolution, with the result of what is termed a double acting pump operation, by giving each piston two suction and two pressure strokes during each revolution, with the subsequent result of hydrostatic balance of all hydraulic members and mechanical balance of all rotary members.

Assuming pump main 37 as main intake connection, (see Fig. 6) the fluid will be sucked into chambers S and S' which are in direct communication through passage 58, or equalizing pipe connections 59. From chambers S and S' the fluid will follow the interconnecting axial bores 31 and 39 of the pintle 14, which will communicate with pump ports 34 and 35 of the pintle.

The discharge of the pump will follow the reverse parallel set of ports and passages as follows. Pump ports 34' and 35' will discharge its fluid through axial passages 32 and 38 of the pintle and thus the fluid will reach exit ports D and D' and the exit main 36 of the pump. Ports D and D' are again equalized by piping 60 and cross passage 61 of the pintle.

Various changes may be made in the detail design of the invention hereinabove specifically described without parting from or sacrificing the invention as defined in the appended claims.

What is claimed is,

1. In a pump or motor of the character described, the combination with a casing, of a pintle rigidly secured therein and projecting into said casing, a rotor rotatable on said pintle, comprising a barrel portion at one end and a circular flange portion at the other end, a radial series of cylinders carried by said circular flange portion, pistons for said cylinders to form a plurality of pumping units with the cylinders, piston actuating means associated with said pumping units, an internal oil circuit formed with said pintle and said rotor to distribute the working fluid of said pumping units, said piston actuating means including planetating means to effect two pumping cycles in said pumping units for each revolution of said rotor.

2. In a pump or motor of the character described, the combination with a casing, of a pintle rigidly secured therein and projecting into said casing, a rotor rotatable on said pintle, comprising a barrel portion at one end and a circular flange portion at the other end, a radial series of cylinders carried by said circular flange portion, pistons for said cylinders to form a plurality of pumping units with the cylinders, piston actuating means associated with said pumping units, an internal oil circuit formed with said pintle and said rotor to distribute the working fluid of said pumping units, said piston actuating means including planetating means to effect two pumping cycles in said pumping units for each revolution of said rotor, and means associated with said planetating means to vary the amplitude of the planetation and thereby the stroke of the pumping units.

3. In a pump or motor of the character described, the combination with a casing, of a pintle rigidly secured therein and projecting into said casing, a rotor rotatable on said pintle, comprising a barrel portion at one end and a circular flange portion at the other end, a radial series of cylinders carried by said circular flange portion, pistons for said cylinders to form a plurality of pumping units with the cylinders, piston actuating means associated with said pumping units, an internal oil circuit formed with said pintle and said rotor to distribute the working fluid of said pumping units, said piston actuating means including planetating means to effect two pumping cycles in said pumping units for each revolution of said rotor, an impeller, coupling means associated with said planetating means between said planetating means and said impeller to change the amplitude of the planetation during rotation, and thereby the stroke of the pistons and the delivery of the pump.

4. In a pump or motor of the character described, the combination with a casing, of a pintle in one end of the casing, a cylinder barrel, rotatably supported in the casing, a cylindrical flange portion extending at one end of the barrel, piston actuating means within said cylindrical flange portion, a radial series of piston and cylinder assemblies for said cylindrical flange por-

tion and surrounding said piston actuating means in working relation therewith, driving means projecting at the opposite end of the casing, coupling means intermediate said driving and piston actuating means respectively to support one end of said piston actuating means, and be driven therewith and means associated with aforesaid coupling means to transversely vary the axis of said coupling means with respect to said driving and piston actuating means respectively to thereby vary the motion of the piston actuating means and the stroke of the pistons.

5. In a pump or motor of the character described, the combination with a casing, of a pintle, a barrel, bearing means for both ends of the barrel mounted in the casing, a cylindrical flange portion extending at one end of the barrel, piston actuating means within said cylindrical flange portion, a radial series of piston and cylinder assemblies surrounding said piston actuating means in working relation therewith, an internal oil circuit formed in said casing and barrel to provide a hydrostatically balanced load transmission between said pintle and said barrel, to unload the bearing means of the barrel, driving means projecting at the opposite end of the casing, coupling means between said barrel and said piston actuating means and intermediate said driving and piston actuating means respectively, to adjustably support the ends of said piston actuating means, and means associated with the last mentioned coupling means to transversely shift the axis of said coupling means with respect to said driving and piston actuating means and thereby vary the stroke of the pistons, and the delivery of the pump.

6. In a pump or motor of the character described, the combination with a casing, of a pintle in one end of the casing, a cylinder barrel, rotatably supported in the casing, a cylindrical flange portion extending at one end of the barrel, piston actuating means within said cylindrical flange portion, a radial series of piston and cylinder assemblies for said cylindrical flange portion and surrounding said piston actuating means in working relation therewith, adjustably mounted driving means for one end of said piston actuating means, in transversely adjustable relation thereto, bearing means for said adjustably mounted driving means, stationarily mounted driving means projecting at the opposite end of the casing, planetating coupling means between said adjustably mounted and said stationarily mounted driving means respectively, and means associated with last mentioned driving means to vary the eccentricity of said adjustably mounted driving means and thereby the stroke of the pistons and the delivery of the pump.

7. In a pump or motor of the character described, the combination with a casing, of a planetating member, bearing means in the casing for said planetating member, supporting means in said bearing means for said planetating member, transversely adjustable means guided in the casing for changing the relative position of said supporting means, to thereby cause the planetating of said planetary member, a radial series of piston and cylinder assemblies grouped about said planetating member and operated thereby, and means to adjust the relative position of said supporting means to vary the amount of planetating and the amount of the stroke of said assemblies.

8. In a pump or motor of the character described, the combination with a casing, of a planetating member, bearing means in the casing for said planetating member, supporting means in said bearing means for said planetating member, transversely adjustable means guided in the casing for changing the relative position of said supporting means, to thereby cause the planetating of said planetary member, valve means in the casing, a stationary pintle in association with said valve means, a barrel rotatably mounted on said pintle and having a radial series of cooperative port openings, a radial series of piston and cylinder assemblies in said barrel grouped about said planetating member and operated thereby, communicating channels between each cylinder barrel port and the outside end of each cylinder of said assemblies, control means to adjust the relative position of said supporting means to vary the amount of planetating and the amount of the stroke of said assemblies, driving means adjacent to said planetating means and means intermediate said driving and planetating means to transmit the driving torque of said driving means to said planetating means.

9. In a pump or motor of the character described, the combination with a casing of a planetating member, bearing means in the casing for said planetating member, supporting means in said bearing means for said planetating member, transversely adjustable means guided in the casing for changing the relative position of said supporting means, to thereby cause the planetating of said planetary member, a radial series of piston and cylinder assemblies grouped about said planetating member and operated thereby, means to adjust the relative position of said supporting means to vary the amount of planetating and the amount of the stroke of said assemblies, crosshead means associated with the pistons, and means formed with said planetary member to provide positive driving connection between each piston and said planetary member in two directions.

10. In a pump or motor of the character described, the combination of a casing, a stationary pintle, a rotor having at one end a barrel portion mounted on said pintle, and at its other end an axially extending circular flange surrounding a circular space, a radial series of cylinders in said flange and opening into said space, pistons in said cylinders, valve means in said pintle, passage means provided in said rotor between said valve means and the outer ends of said cylinders for the supply and discharge fluid respectively, driving means for said rotor, piston actuating means associated with the inner ends of said pistons, torque transmitting means between the barrel portion of said rotor and said piston actuating means, said torque transmitting means comprising an axially extending flat portion of said piston actuating means, and a receiving groove in said barrel in reciprocating bearing relation thereto, and means associated with said piston actuating means to vary the stroke of the pistons and the delivery of the pump.

11. In a pump or motor of the character described, the combination of a casing, a stationary pintle, a rotor having at one end a barrel portion mounted on said pintle, and at its other end an axially extending circular flange surrounding a circular space, a radial series of cylinders in said flange and opening into said space, pistons in said cylinders, valve means in said pintle, passage means provided in said rotor between said valve means and the outer ends

of said cylinders for the supply and discharge fluid respectively, driving means for said rotor, piston actuating means associated with the inner ends of said pistons, torque transmitting means between the barrel portion of said rotor and said piston actuating means, said torque transmitting means comprising an axially extending flat portion of said piston actuating means, and a receiving groove in said barrel in reciprocating bearing relation thereto, and means associated with said piston actuating means to vary the stroke of the pistons and the delivery of the pump, said means including a rotary torque transmitting means mounted in the casing, a flat extension projecting from said piston actuating means, and a mating cooperating slot provided in said torque transmitting means, to transmit the driving torque of said torque transmitting means to said piston actuating means while the one being adjusted with respect to the other.

12. In a pump or motor of the character described, the combination of a casing, a stationary pintle, a rotor having at one end a barrel portion mounted on said pintle, and at its other end an axially extending circular flange surrounding a circular space, a radial series of cylinders in said flange and opening into said space, pistons in said cylinders, valve means in said pintle, passage means provided in said rotor between said valve means and the outer ends of said cylinders for the supply and discharge fluid respectively, piston actuating means associated with the inner ends of said pistons, control means associated with said piston actuating means, coupling means between said control means and said piston actuating means, driving means coaxially disposed with the rotor, a secondary coupling means between said driving means and said control means to adjustably engage one end of said control means and the adjacent end of said driving means respectively.

13. In a pump or motor of the character described, the combination of a casing, a stationary pintle, a rotor having at one end a barrel portion mounted on said pintle, and at its other end an axially extending circular flange surrounding a circular space, a radial series of cylinders in said flange and opening into said space, pistons in said cylinders, valve means in said pintle, passage means provided in said rotor between said valve means and the outer ends of said cylinders for the supply and discharge fluid respectively, piston actuating means associated with the inner ends of said pistons, control means associated with said piston actuating means, coupling means between said control means and said piston actuating means, driving means coaxially disposed with said rotor, a secondary coupling means between said driving means and said control means to adjustably engage one end of said control means and the adjacent end of said driving means, said means comprising a torque transmitting planetating member, having flat extension portions at its ends in crosswise relation, and cooperative slots, provided in the respective ends of said control means and said driving means.

14. In a pump or motor of the character described, the combination of a casing, a stationary pintle, a rotor having at one end a barrel portion mounted on said pintle, and at its other end an axially extending circular flange surrounding a circular space, a radial series of cylinders in said flange and opening into said space, pistons in said cylinders, valve means in said pintle, passage means provided in said rotor between said valve means and the outer ends of said cylinders for the supply and discharge fluid respectively, piston actuating means associated with the inner ends of said pistons, control means for said piston actuating means, supporting means for said piston actuating means to planetate said piston actuating means, said supporting means comprising a flat portion carried by said piston actuating means at each end thereof and a receiving straight groove in the adjacent ends of said rotor and said control means respectively, fixed driving means adjacent to said control means and means between said driving and control means to provide free adjustment for said control means with respect to said driving means during the rotation of said fixed driving means.

15. In a pump or motor of the character described, the combination with a casing, of a pintle rigidly secured therein, a cylinder barrel rotatably supported in the casing and on said pintle respectively, driving means for said rotor, a cylindrical flange section carried by one end of said cylinder barrel and extending axially thereof, supporting means on each end of said barrel, bearing means for said supporting means, cylinders in said circular flange portion, pistons for said cylinders, a crosshead associated with each piston, valve means provided in the pintle, fluid supply means between the pintle and the cylinders, piston actuating means, associated with the crossheads, said means including a planetating member having circumferentially disposed groove ways to operatively engage the piston cross heads for reciprocating the same, control means adjacent to said piston actuating means to vary the amplitude of planetation of said piston actuating means and thereby the stroke of the pistons, torque transmitting means between said piston actuating means and said barrel and control means respectively, and planetating means between said control means and said driving means, to thereby maintain driving relation between said driving means and said control means, during the stroke adjustment of the pistons, said control means comprising an adjustable bearing housing adopted for transverse shifting operation with respect to the axis of said driving means, a plurality of axially spaced radial bearings mounted in said housing, a rotor for said radial bearings and means to secure said bearings on said rotor.

ELEK BENEDEK.