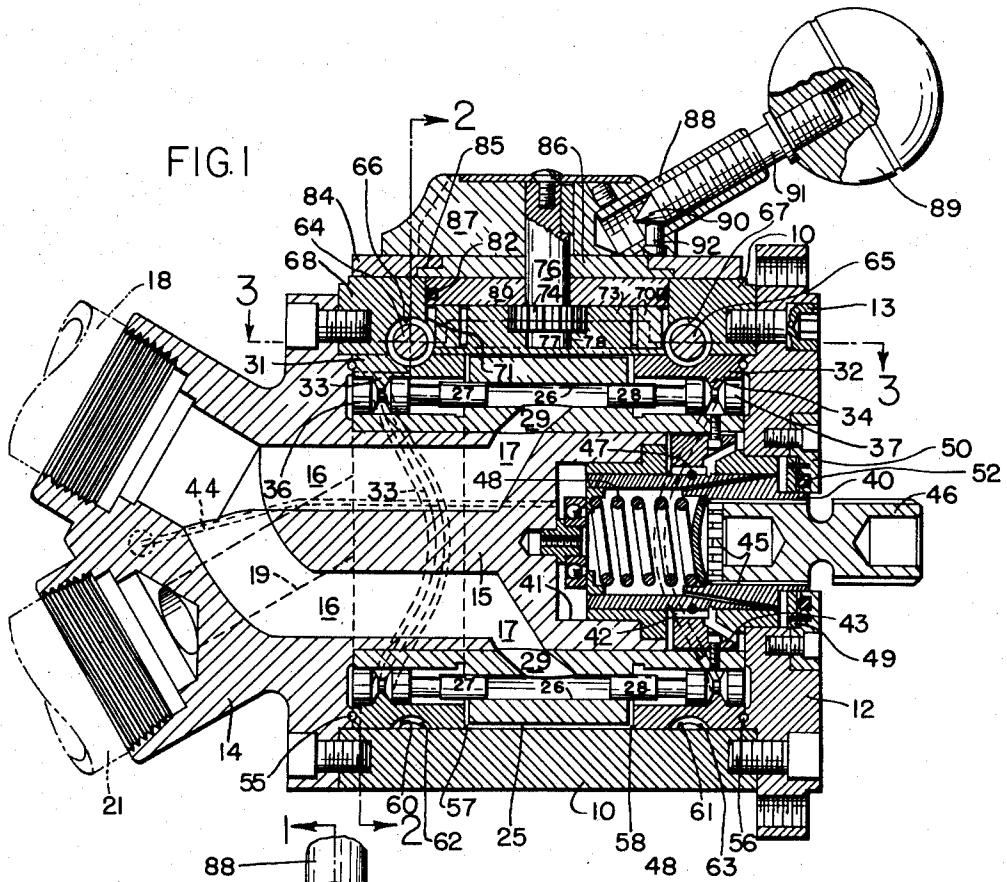
Dec. 23, 1958 W. S. FALLON 2,865,304

FLUID PUMP OR MOTOR

Filed Feb. 14, 1955 2 Sheets-Sheet 1

FIG. 1



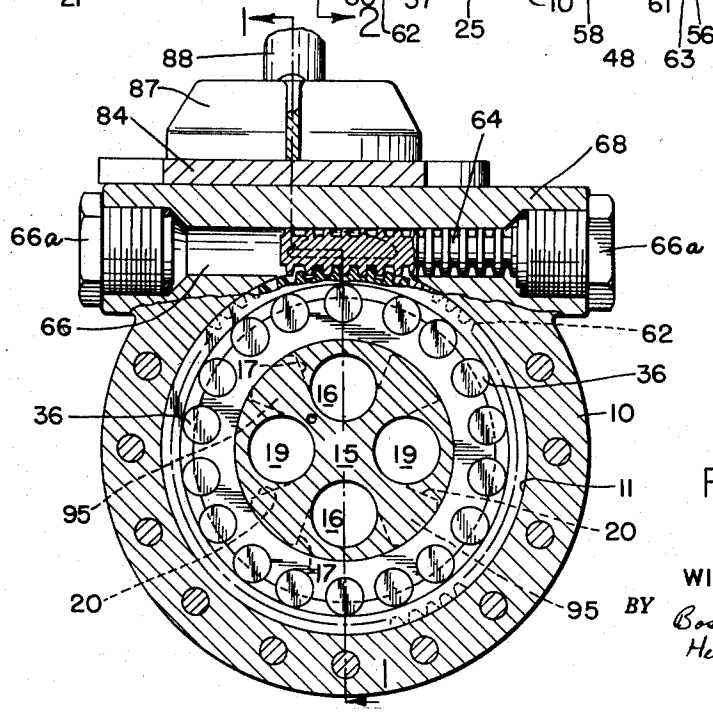


FIG. 2

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Dec. 23, 1958 W. S. FALLON 2,865,304

FLUID PUMP OR MOTOR

Filed Feb. 14, 1955 2 Sheets-Sheet 2

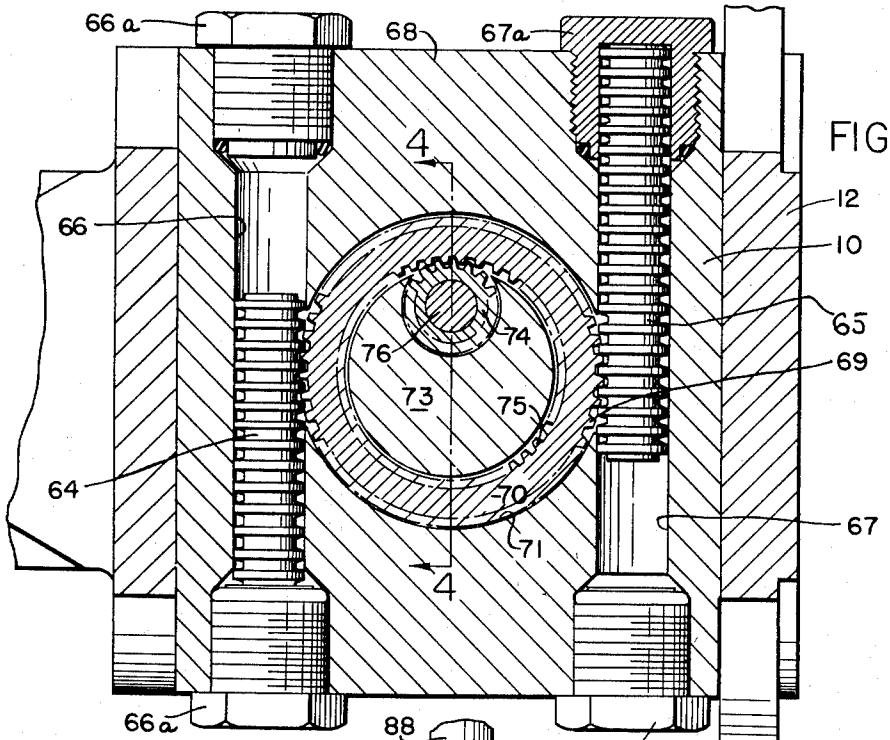


FIG. 3

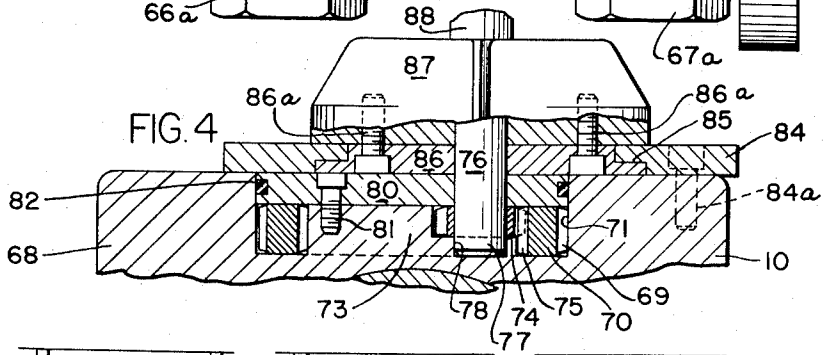


FIG. 4

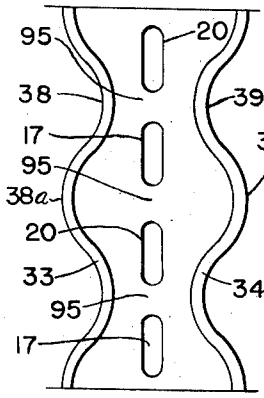


FIG. 5

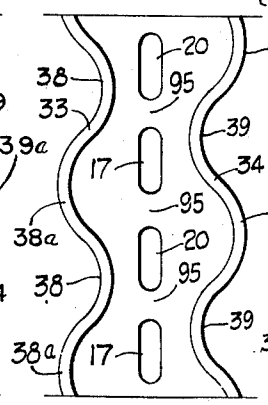


FIG. 6

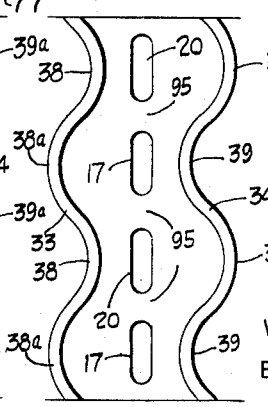


FIG. 7

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FLUID PUMP OR MOTOR

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Application February 14, 1955, Serial No. 488,028

8 Claims. (Cl. 103—162)

This invention relates to fluid pumps or motors, and more particularly to fluid pumps or motors of the positive displacement type wherein provision is made for varying the displacement of the pump or motor. The invention is disclosed herein in conjunction with a Motion Converting Mechanism described and claimed in Patent No. 2,349,314 dated May 23, 1944, and the Fluid Pump or Motor described and claimed in my prior Patent No. 2,417,816, dated March 25, 1947, and the improvement comprises means whereby the device of these patents is made into a variable displacement pump or motor.

The general object of the present invention is the provision of an efficient and sturdy variable displacement fluid pump or motor. More specifically the object of this invention is to provide, in an aircraft type pump, a compact, infinitely variable displacement control mechanism, that lends itself to direct or remote manual control to be incorporated in a light weight case with a minimum of metal while providing the necessary strength over the control area. Another object is the provision of a variable displacement pump or motor of the type wherein opposed pistons are urged toward and away from each other by sinuous cam members, Another object is the provision of such a pump or motor which is hydraulically balanced throughout. Another object is the provision of a pump or motor in which the displacement can be varied from maximum to zero while the balanced operation of the device is maintained. Another object is the provision of a compact, sturdy and effective mechanism for varying the displacement of a fluid pump or motor of the general type disclosed in my aforesaid Patent No. 2,417,816.

In the following description the machine will be referred to as a pump, but it is to be understood that it may also be used as a motor. My prior Patent No. 2,417,816 discloses an efficient, balanced pump comprising a housing containing a rotor having a plurality of axially extending cylinders and a pair of opposed pistons operating in each cylinder. The pistons are moved toward and away from each other by engagement with substantially identical sinuous cams contained in the pump housing, and the cylinders communicate successively with inlet and discharge passageways as the rotor rotates. The cams are disposed so that the peaks of one cam are directly opposite the peaks of the other cam and, hence, the cams move the pistons toward each other and then away from each other, the motion of the pistons being substantially identical but in opposite directions at any given instant.

According to the present invention, the pump of my prior patent is made into a variable displacement pump by the provision of means for rotating the cams with respect to each other so that the movement of the pistons with respect to each other can be reduced. The cams can be adjusted to a position in which the valleys of one cam are directly opposite the peaks of the other cam, in which case the pistons will move simultaneously in the same directions, and the net displacement of the

pump will be zero, or to any positions of adjustment between the zero position and the maximum position.

A preferred form of the invention is illustrated in the accompanying drawings in which—

Figure 1 is a longitudinal cross-section through a pump embodying my invention, the section being through the axis of the pump proper and through the central axis of the adjusting mechanism, as indicated by the line 1—1 of Figure 2.

Figure 2 is a transverse section taken along the line 2—2 of Figure 1.

Figure 3 is a horizontal section on an enlarged scale through the adjusting mechanism, taken as indicated by line 3—3 of Figure 1.

Figure 4 is a fragmentary vertical section through the adjusting mechanism taken as indicated by line 4—4 of Figure 3, and

Figures 5, 6 and 7 are diagrams showing developments of the cams and the inlet and discharge ports of the pump for maximum displacement, intermediate and zero displacement, respectively.

As shown particularly in Figures 1 and 2 of the drawings, a preferred form of pump made according to my invention comprises a housing **10** having a cylindrical recess or chamber **11** therein. The housing is closed at one end by a cover plate **12** secured thereto by any convenient means such as screws **13**, and at its other end it is closed by an inlet and discharge member **14** which has a projection **15** extending into the chamber **11** concentrically therewith. Member **14** is provided with inlet passages **16** communicating with inlet ports **17** and inlet conduit **18**, and with similar discharge passages **19** which communicate with discharge ports **20** and discharge conduit **21**.

A rotor **25** is journalled on the projection **15** for rotation in the housing **10**, and is provided with a plurality of axially extending cylinders **26**. Opposed pistons operate in the cylinders **26**, the pistons in one annular row being designated by reference character **27** and those in the opposite row by reference character **28**. Each cylinder is provided with a passage **29**, which successively connects the cylinders to the inlet and discharge ports **17** and **20** as the rotor is rotated.

In order to provide for reciprocation of the pistons **27** and **28**, cam rings **31** and **32** are mounted within the housing **11**. These cam rings have substantially identical sinuous cams **33** and **34** thereon, which respectively engage grooved heads or followers **36** and **37** formed integrally with the rear portions of pistons **27** and **28**. With this arrangement, with the cam rings and cams held stationary and the rotor driven, the pistons are reciprocated in the cylinders **26** by the cams **33** and **34**. Each cam is double, i. e., has two complete sinusoidal curves so that each piston makes two complete cycles of reciprocation for each revolution of the rotor. With the cams in the position shown in Figures 1 and 5, wherein the peaks **38** of cam **33** are directly opposite corresponding peaks **39** of cam **34** and intervening valleys **38***a* and **39***a* are also directly opposite each other, the motion of the pistons is simliar but always opposite in direction and the pumping action is at maximum as the cylinders are successively connected to the inlet and discharge passages through the passages **29**.

In order to drive the rotor **25**, a drive coupling **40** is supported in appropriate bearings within a recess **41** in the projection **15** and makes a splined driving connection, as at **42**, with a driving member **43** which is secured in fixed axial relationship and in driving relation to the inner surface of the rotor **25**. Leakage of fluid into chamber **41** is discharged through passage **44** which leads to the exterior of the housing and may be connected to the sump by any convenient conduit (not shown). The

drive coupling 40 has internal splines 45 which receive the splined end of stub shaft 46. Shaft 46 may be driven by any convenient means. Axial movement between member 43 and coupling 40 is prevented by a snap ring 47.

In order to prevent leakage of fluid around the driving connections, coupling 40 is urged outwardly by a spring 48 and makes a running fit against seal plate 49, which, in turn, is sealed to the stationary plate 50 as by means of the O-ring seal 52.

The parts heretofore described are, in general, constructed and arranged according to my said Patent No. 2,417,816 and in general, the operation of the device is as described in that patent except for the adjusting mechanism to which the present application particularly relates. As described in my said patent, the pump is hydraulically balanced throughout.

In order to provide for ready adjustment of the displacement of the pump, the cam rings 31 and 32 are made rotatable within the housing 10, ball-bearings 55 and 56 being provided for rings 31 and 32 to reduce the friction between the cam rings and the stationary end members 12 and 14. Rotor 25 is spaced from the cam rings as at 57 and 58, this spacing being maintained by the snap ring 47 providing a separable means to drive the rotor and hold it in spaced relationship with the housing ends, for the prevention of preloading and galling when case pressure or accidental mechanical unbalance is present. Adjustment of the position of the cam rings and the locking of the cam rings in the desired position of adjustment is obtained by providing the cam rings with arcuate recesses 60 and 61 which are formed with gear teeth 62 and 63 respectively. The teeth 62 and 63 on the cam rings are engaged by circular racks 64 and 65, which are slidably mounted in transverse opening 66 and 67, respectively, in the enlarged boss portion 68 of the housing member 10, as shown particularly in Figure 2. Openings 66 and 67 intersect the inner wall of the housing 10 and thus communicate with the chamber 11 so that the racks can engage the gear teeth on the cam rings in the regions where the cam rings project into the passages 66 and 67. The ends of passages 66 and 67 are closed by end fittings 66*a* and 67*a* which are recessed as shown in Figure 2 so that the racks can telescope into them. The end fittings also act as stops for the racks.

In order to adjust the position of the circular racks 64 and 65 and thus to rotate the cam rings 31 and 32, the racks are engaged, as shown particularly in Figures 1 and 3, by the external teeth 69 of an internal-external gear 70 which is disposed in a circular opening 71 in the boss 68. Gear 70 fits over a projection 73 in the center of the opening 71 and is guided thereby. In order to provide simplicity and a reduction in weight and reduce the space occupied the axis of the control substantially coincides with the axis of the pump; this construction would normally weaken the housing along this axis. This is corrected by providing a connecting ring-gear surrounding a projection, the metal of which bridges that sector to provide uniform strength in the case when otherwise it would be machined away as evident on Figs. 3 and 4.

The gear is rotated by a pinion 74 (see also Figure 4) which engages the internal teeth 75 thereof. Pinion 74 is mounted on shaft 76, the lower end 77 of which projects into a recess 78 in projection 73, the shaft also being supported by circular plate 80 which closes the upper portion of the opening 71. Plate 80 is secured in place by screws 81 extending into projection 73, and leakage around the plate is prevented by an O-ring seal 82.

The manual control assembly comprises a plate 86 secured by screws 86*a* to the under side of index member 87 to retain dial plate 84 at shoulders 85, the dial plate 84 as shown on Fig. 4 is secured to boss 68 by screws 84*a*, with adjusting member keyed to shaft 76. Remote control may be provided by mounting the assembly by screws 84*a* on a control panel and connected to shaft 76 by a flexible or other suitable shaft. Adjusting member 87 has a threaded sleeve 88 projecting therefrom which carries adjusting handle 89. The conical point 90 of the shank 91 of handle 89 engages a locking pin 92. Thus, by screwing the handle member inwardly, locking pin 92 can be made to engage cover plate 84 to lock the adjusting mechanism in a given position of adjustment. When the locking pin 92 is released, handle 89 can be turned about the axis of shaft 76 to adjust the position of the cam rings, the motion of the handle being transmitted to the cam rings through the pinion 74, internal-external gear 70 and circular racks 64 and 65.

The effect of the adjustment is shown diagrammatically in Figures 5 and 6. In Figure 5 the cam rings are set to position the cams 33 and 34 for maximum displacement of the pump, with the peaks 38 of cam 33 directly opposite peaks 39 of cam 34. In this position the cams may be considered to be 180° out of phase with each other, so that the pistons move oppositely to each other at all times. It will be noted that the lands 95 between inlet ports 17 and discharge ports 20 are disposed in positions where the relative displacement of the pistons is at a minimum.

By operation of the adjusting mechanism as described above, the cams can be moved to reduce the relative motion between the pistons to zero or to any desired amount between maximum and zero; i. e., the cams can be adjusted to an "in phase" position. This is accomplished by moving the cams simultaneously in opposite directions, Figure 6 showing the cams in position for an intermediate displacement and Figure 7 showing the cams in the position for zero displacement of the pump. Since the cams are double, it requires only 90° of relative rotation to change the phase relationship from 180° out of phase to in phase; this is accomplished by rotating the cams 45° in opposite directions. It will be evident from an inspection of Figure 7 that while the pistons continue to reciprocate, they reciprocate together and in the same direction and at the same velocity at all times so that no fluid is displaced by the pistons as the rotor rotates. In intermediate positions the net displacement is intermediate between the maximum and zero. It is to be noted, however, that since both cams are moved simultaneously in opposite directions and are moved equal amounts, the relationship between the motion of the pistons and the inlet and discharge ports 17 and 20 of the projection 15 remains constant so that proper pumping action and balanced operation are obtained at all times.

In the preferred form of the apparatus, the end fittings 66*a* and 67*a* are adjusted to provide stops for the racks 64 and 65 approximately 5° short of the 180° out-of-phase relationship shown in Figure 5. This mode of adjustment provides a region of substantially no displacement at the lands between the ports 17 and 20 and, thus, substantially reduces pulsation and noise in the operation of the pump. The control is preferably arranged so that when the control handle 89 is rotated 180°, the cams are counter-rotated 45° each, and the displacement of the pistons is reduced from maximum in one direction to zero displacement. By turning the control handle 360°, the cams are counter-rotated 90° each, and the flow is reversed from maximum displacement in one direction to maximum displacement in the opposite direction. Thus, the displacement may be controlled to any desired amount from maximum in one direction through zero to maximum in the opposite direction simply by the manipulation of the control handle.

Inasmuch as the cams and pistons at opposite ends of the rotor are substantially identical, the running intertia load is balanced substantially equally between the two cams. The direction of the force on the cams tends to cause the cams to rotate in the same direction as the rotor. The cams, however, are connected by racks 64 and 65 to opposite sides of ring gear 70 so that the inertia forces exerted by the cams on the ring gear are opposed

to each other and substantially balanced. Therefore, adjustment can be carried out easily, inasmuch as substantially the only force required to rotate the cams in opposite directions is a force sufficient to overcome the friction of the cam adjusting parts. Thus, fingertip control is provided, the pump can be adjusted easily while it is running since the inertia forces are in balance, and the pump is in mechanical and hydraulic balance.

Those skilled in the art will appreciate that various changes and modifications can be made in the preferred form of the invention shown herein without departing from the spirit and scope thereof. The essential characteristics of the invention are defined in the appended claims.

I claim:

1. A machine of the character described, comprising a housing having a recess therein, a projection extending axially into said recess, a rotor journalled on said projection and having a series of axially disposed cylinders therein, said projection having inlet and discharge passages therein with which said cylinders are connected in succession, a pair of opposed pistons operable in each cylinder, a pair of cam rings disposed within said housing, sinuous internal cams on said rings for positively reciprocating said pistons in both directions during rotation of said rotor, said cams each having two peaks and two valleys and being substantially identical and adapted to cause said pump to displace a maximum amount of fluid when the peaks of one cam are opposite the peaks of the other cam and to displace substantially no fluid when the peaks of one cam are opposite the valleys of the other cam, and means for simultaneously adjusting the position of the cams equal amounts in opposite directions with respect to said inlet and discharge passages and thereby varying the displacement of said machine, said adjusting means comprising gear teeth on said cam rings, a circular rack engaging the teeth of each cam ring, a gear engaging the teeth of the racks, one rack being disposed on one side of said gear and the other rack being disposed on the opposite side of said gear, and means for rotating the gear to move one rack in one direction and the other rack in the opposite direction, thereby simultaneously to adjust the position of the cams.

2. Apparatus according to claim 1 wherein the gear is provided with external teeth engaging the teeth on said racks and with internal teeth and is rotated by means of a pinion engaging the internal teeth of the gear.

3. Apparatus according to claim 2 wherein the circular racks and the gear and pinion for operating the same are mounted in a boss formed on the exterior of the housing.

4. Apparatus according to claim 3 wherein means are provided for locking the gear in desired positions of adjustment.

5. A pump of the character described, a housing having a cylindrical recess therein, the cover on one end of the housing carrying a projection extending axially into said recess, and ending in spaced relation to the other end of the housing and having suction and discharge passages therein and having fluid connections to the exterior of said housing end in acute angle diverging relation to each other and to the axis of the housing, said projection providing opposite suction and opposite discharge openings through the periphery thereof and arcuate lands therebetween, a rotor mounted thereon having a series of axial cylinders therein and fluid ports for connecting said openings and said cylinders in succession during the rotation of the rotor, opposed pistons operable in said cylinders, reduced end sections on said rotor surrounded by multiple cycle cam carrying rings, engaging and reciprocating said pistons in both directions when said rotor is rotated, providing a means to balance mechanically and hydraulically said rotor in said housing and on said projection, and means whereby the centrifugal force in said rotating rotor is added to the barometric pressure to supercharge the cylinders, means to rotate said rotor comprising a separable splined driver extending through said other end of said housing, control means for simultaneously counter rotating said cams from out of phase to in phase then out of phase to infinitely control the displacement in either direction of flow.

6. Apparatus according to claim 5 wherein means are provided for balancing the inertia load of the running pump while the displacement is infinitely varied in either direction.

7. A machine of the character described, comprising a housing having a recess therein, a projection extending into said recess, a rotor journaled on said projection and having a series of axially disposed cylinders therein, said projection having opposite suction and opposite discharge openings through the periphery thereof and arcuate lands therebetween, said rotor having fluid ports for connecting said openings and said cylinders in succession during the rotation of said rotor, opposed pistons operable in said cylinders, reduced end sections on said rotor surrounded by a multiple cycle cam carrying ring, engaging and reciprocating said pistons when said rotor is rotated, suction and discharge fluid connections on one end of said housing connecting to said openings means to rotate said rotor comprising a separable spline extending through the other end of said housing, means for rotating said cams simultaneously in opposite directions comprising three rotating members, and two reciprocating members each engaging two of the rotating members, control means to actuate one of said members to vary the displacement of said pump.

8. A pump of the character described, a housing having a cylindrical recess therein, a projection extending axially into said recess from one end and ending in spaced relation to the other end of the housing and having multiple suction and discharge passages opening on the periphery of said projection, multiple axial cylinder and opposed piston carrying rotor journaled on said projection and having fluid passages connecting said fluid openings with said cylinders, reduced end sections on said rotor providing guideways for said pistons and surrounded by multiple cycle cam carrying rings engaging and reciprocating said pistons when said rotor is rotated, a driving coupling rotatably supported by said projection and said other end of the housing, a separable connecting means between said coupling and said rotor maintaining a fixed space relationship between said rotor ends and said housing ends.

References Cited in the file of this patent

UNITED STATES PATENTS

2,417,816	Fallon	Mar. 25, 1947
2,439,668	Mercer	Apr. 13, 1948
2,617,360	Barker	Nov. 11, 1952
2,691,350	Greer	Oct. 12, 1954

FOREIGN PATENTS

851,663	France	Oct. 9, 1939
865,673	France	Mar. 3, 1941