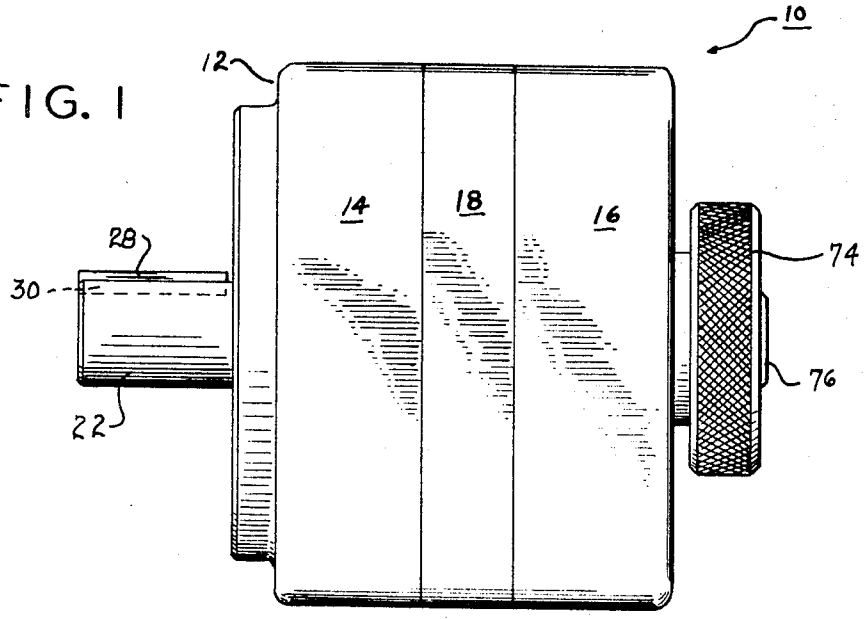
June 2, 1970 R. T. EDDY 3,515,496

VARIABLE CAPACITY POSITIVE DISPLACEMENT PUMP

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FIG. 1



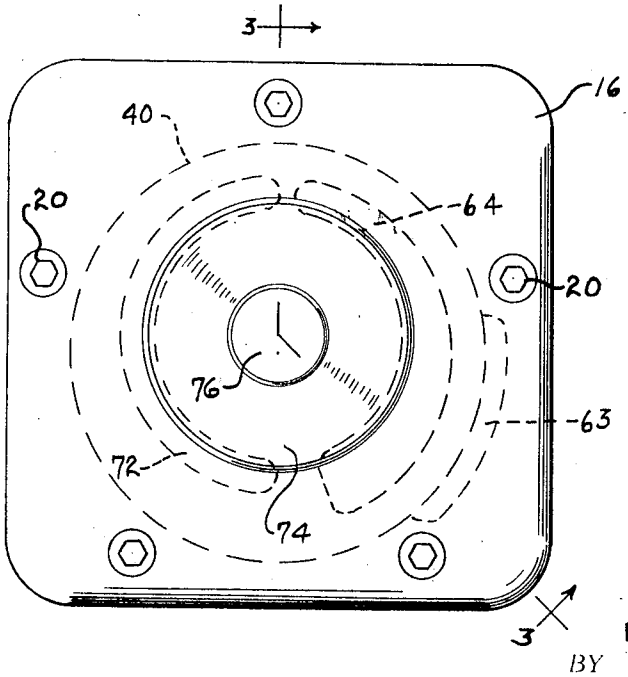


FIG. 2

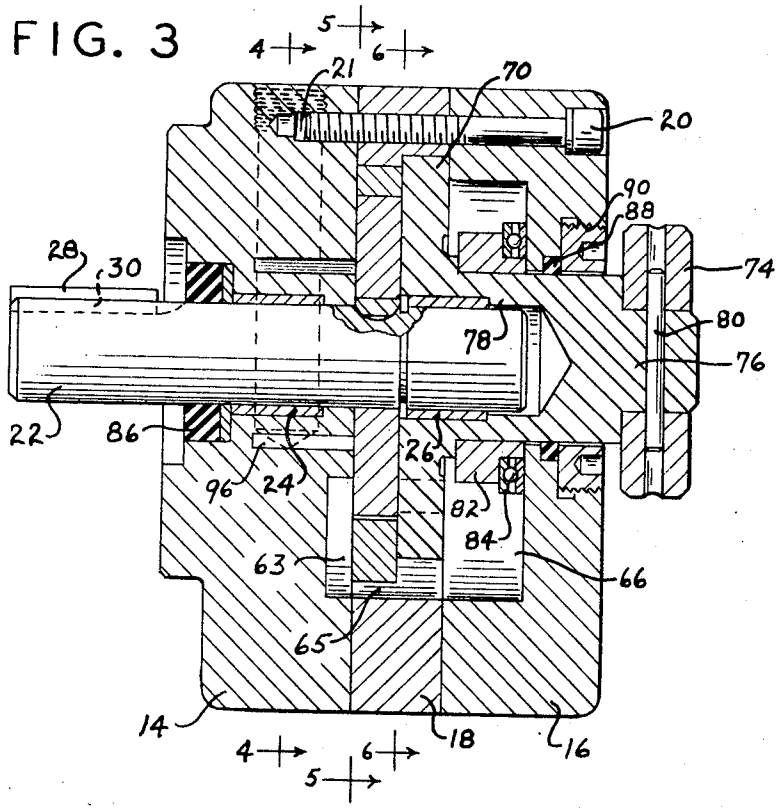
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VARIABLE CAPACITY POSITIVE DISPLACEMENT PUMP

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FIG. 3



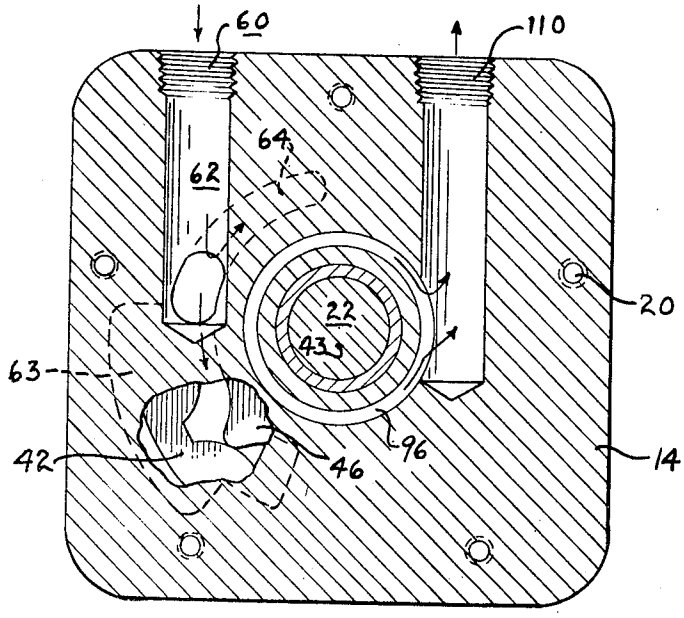


FIG. 4

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FIG. 5

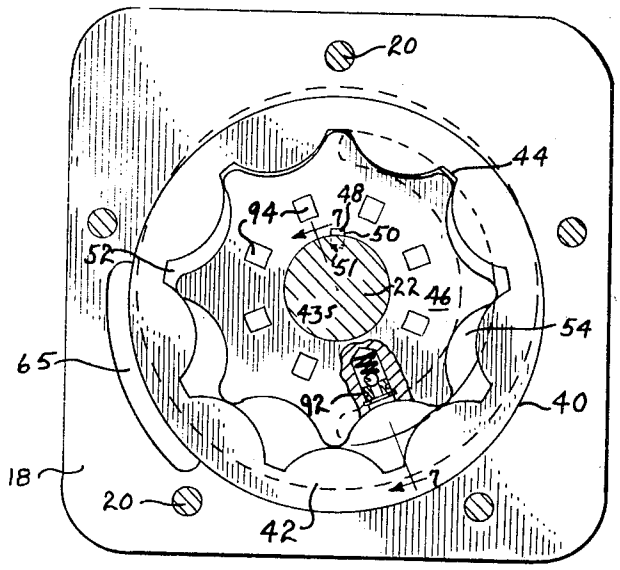


FIG. 7

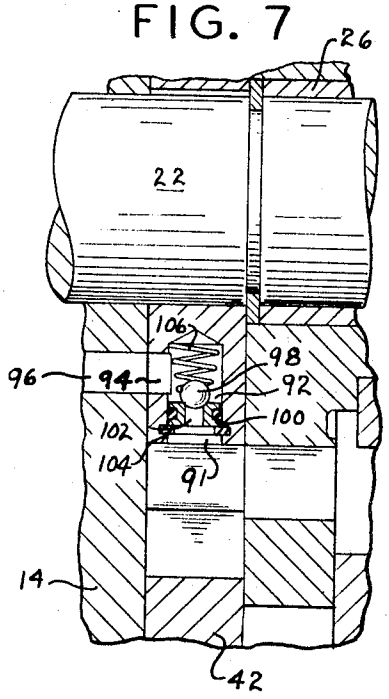


FIG. 6

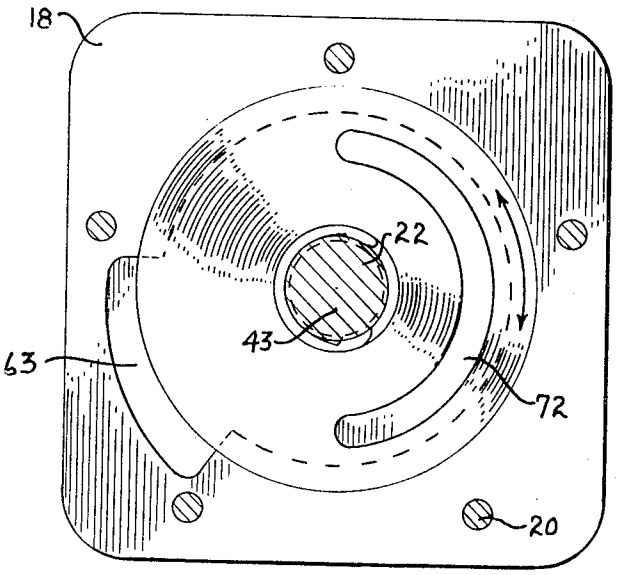
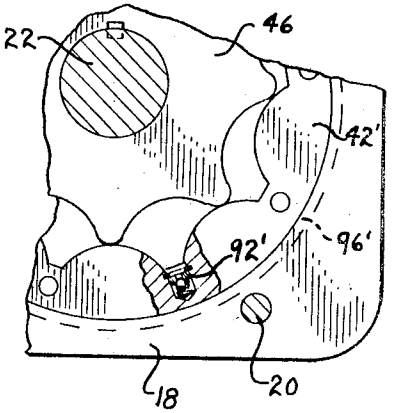


FIG. 8



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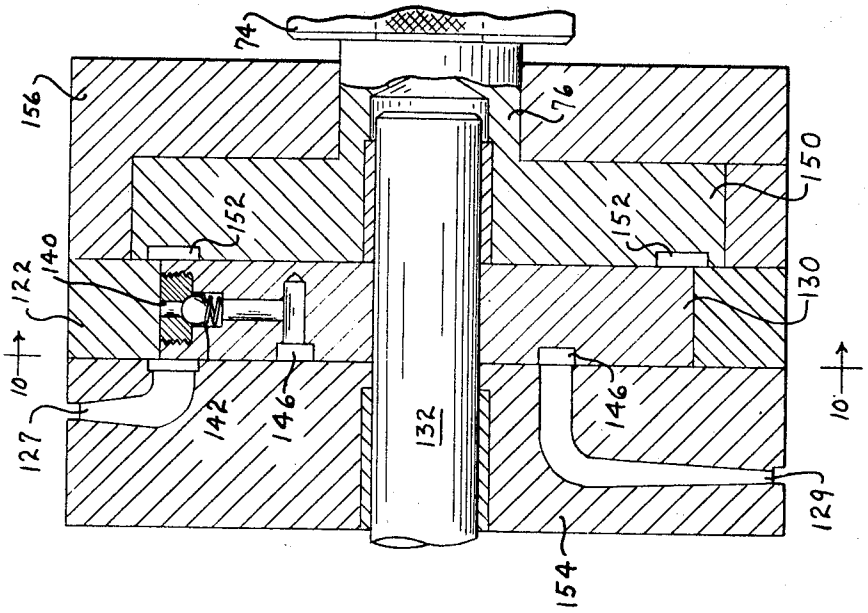


FIG. 9

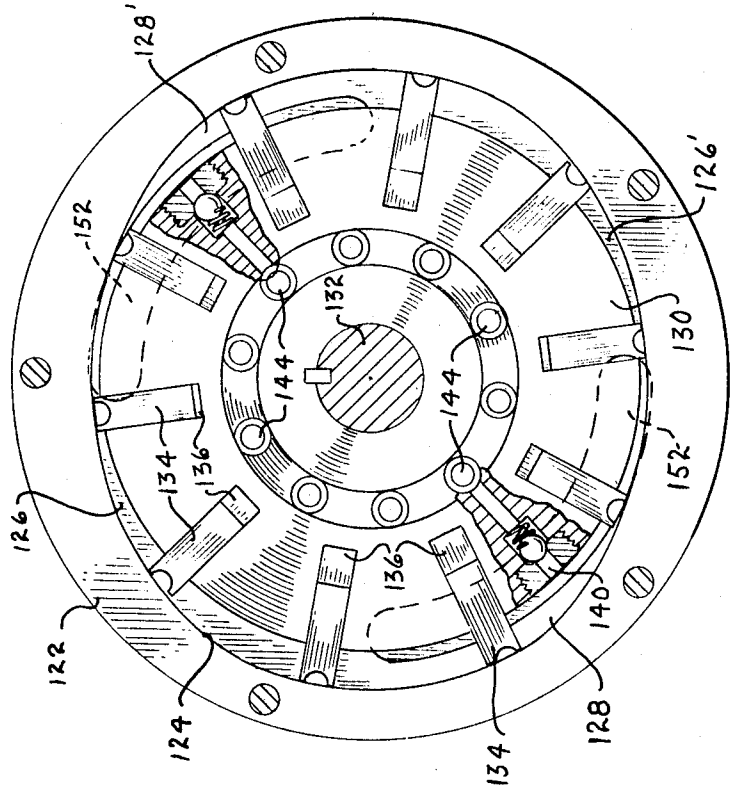


FIG. 10

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3,515,496

VARIABLE CAPACITY POSITIVE DISPLACEMENT PUMP

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Int. Cl. F04c 1/02, 15/02, 17/06
U.S. Cl. 417—440 10 Claims

ABSTRACT OF THE DISCLOSURE

A pump of the positive displacement type having a rotor defining a series of expanding and a series of contracting pump chambers, a fluid inlet passage connected to the inlet chambers and fluid outlet passages connected to the contracting chambers. A rotatable port plate is mounted along the side of the chamber for removing a portion of the fluid from the contacting chambers to vary the effective pumping capacity of the contracting chambers.

For the generation of oil pressure for hydraulic systems, the rotary positive displacement pump is used almost exclusively, these pumps consisting principally of the vane type and the external gear and internal gear types. In many applications of the hydraulic systems having a pump and a motor driven by the fluid from the pump, a variable fluid delivery from the pump is essential for proper or effective operation of the system, and in the past this variable delivery from the pump has been accomplished primarily either by varying the speed of the pump, by regulating a pressure responsive valve in the output line of the pump to by-pass the fluid to the intake side of the pump, or, in the vane type pump, by varying the eccentricity of the vane track relative to the rotor axis. In each of these methods of varying the pump output and/or pressure, the mechanism has been relatively complex, unreliable, or difficult to adjust precisely to the desired pressure or pump delivery. It is therefore one of the principal objects of this invention to provide a positive displacement pump in which the fluid delivery therefrom can easily and readily be adjusted over a wide range to satisfy requirements, and which is relatively simple in construction and operation.

Another object of the invention is to provide a variable positive displacement pump of either the vane or Gerotor types in which the mechanism for varying the delivery can effectively be regulated to give the desired output pressure and flow, and which consists of a few relatively small, easily made and assembled parts.

Still another object of the invention is to provide a vane or Gerotor type positive displacement pump in which the number of effective pump outlet chambers may be varied to obtain the desired pump delivery and which can readily be varied over a range from zero output to maximum output by the manipulation of a single, easily controlled adjustment means.

A further object is to provide a pump of the aforesaid Gerotor type pump which is so designed and constructed that it will give long, trouble-free service, and which will maintain its adjustments to provide dependable delivery of the required fluid supply for a variety of hydraulic systems.

Additional objects and advantages of the invention will become apparent from the following description and accompanying drawings, wherein:

FIG. 1 is a side elevational view of a Gerotor type pump embodying the present invention;

FIG. 2 is an end elevational view of the pump shown in FIG. 1;

FIG. 3 is a vertical cross sectional view of the pump shown in FIGS. 1 and 2, the section being taken on line 3—3 of the latter figure;

FIG. 4 is a vertical cross sectional view of the pump, the section being taken on line 4—4 of FIG. 3;

FIG. 5 is a vertical cross sectional view, the section being taken on line 5—5 of FIG. 3;

FIG. 6 is a vertical cross sectional view, the section being taken on line 6—6 of FIG. 3;

FIG. 7 is an enlarged fragmentary cross sectional view, the section being taken on line 7—7 of FIG. 5;

FIG. 8 is an enlarged fragmentary cross sectional view similar to FIG. 5, showing a variation of the present invention;

FIG. 9 is an axial cross sectional view of a vane type positive displacement pump embodying the present invention; and

FIG. 10 is a cross sectional view taken on line 10—10 of FIG. 9.

Referring more specifically to the drawings and to FIGS. 1, 2 and 3 in particular, numeral 10 designates generally a Gerotor pump embodying the present invention, having a housing 12 consisting of outer sections 14 and 16 and an intermediate section 18 interposed between the two outer sections and held firmly therebetween by a plurality of screws 20 extending through outer section 16 and intermediate section 18 and threadedly received in a bore 21 in section 14, the screws retaining the three sections firmly together to form a unitary structure. The pump shown in the drawings is primarily intended for use in a hydraulic system (not shown) including a reservoir in which the pump receives its supply of fluid, the hydraulic motor driven by the fluid from the pump, and hydraulic lines interconnecting the reservoir, pump and motor. The type of system just described is considered conventional for the purpose of the invention and will not be described in further detail herein.

The pump is driven by a motor connected to input shaft 22 journalled in bearing 24 in section 14, and in bearing 26 in sections 16 and 18, in a manner more fully described hereinafter. The pump may be driven by a direct drive coupled to the shaft, or by a belt and a sheave mounted on the shaft and keyed thereto by a key and keyway 28 and 30 in the outer end of the shaft. While the present pump mechanism is designed primarily for use with hydraulic fluid, it may be used satisfactorily under certain conditions in connection with other types of fluid, including water, fuel and lubricating oil, and any changes and modifications necessary to adapt the pump to these various other uses are considered within the scope of the present invention.

The pump housing 12 contains a circular pump cavity 40 in which is disposed an internally toothed Gerotor element 42 adapted to rotate in cavity 40. The cavity and element are offset from the axis of shaft 22 and, as shown in the drawings, are off-set downwardly from the center of the shaft to the point indicated by numeral 43. Element 42 contains nine teeth on the internal periphery thereof, spaced from one another by lands 44. Disposed within element 42 is an externally toothed element 46 mounted on shaft 22 and secured to the shaft by a key 48 and keyways 50 and 51 in element 46 and shaft 22, respectively. Element 46 contains eight teeth which cooperate with the teeth on internally toothed element 42 to form intake and discharge chambers, indicated generaly by numerals 52 and 54, as the two elements rotate in the same direction, element 42 being journalled in the circular side walls of cavity 40 in sliding contact therewith.

Pump section 14 contains the inlet passage 60 consisting of an inwardly extending conduit 62 and an arcuate slot 64 communicating with inlet chambers 52 along the

inner and outer peripheries of Gerotor elements 42 and 46, respectively. Inlet passage 60 is normally connected into the hydraulic system in the return line from the hydraulic motor and is also connected to a reservoir in the system by a supplemental intake passage 63 disposed in section 14 along the side of the two Gerotor elements. The supplemental passage is connected to the reservoir through a passage 65 in section 18 and a passage 66 in section 16 and by a passage extending through said latter section to a line (not shown) connected to the reservoir.

Mounted in section 18 along the side of the two Gerotor elements opposite inlet passage 64 is a rotatable plate 70 having an arcuate slot 72 therein communicating with the space between the internal and external teeth of Gerotor elements 42 and 46. This arcuate slot communicates directly with return passage 66 and hence permits the fluid to flow from the contracting chambers between the two Gerotor elements to the reservoir or to be circulated through the pump from passage 66 to intake pasage 64. Port plate 70 is rotatable to various angular positions on shaft 22 and is mounted on the external surface of bearing 26, the plate rotating to place arcuate slot 72 in various angular positions with respect to the contracting fluid chambers 54 and thereby to control the output of the contracting chambers. The angular position of slot 72 in port plate 70 is controlled by an adjustment hand wheel or knob 74 mounted on a shaft 76 which is connected directly to the rotatable port plate by inner extension 78 of shaft 76. Wheel 74 is rigidly secured to shaft 76 by a pin 80 extending radially through the wheel and the shaft so that any rotation of the wheel results in an angular adjustment of the port plate. Shaft 76 is mounted in a retainer or spacer ring 82 and annular thrust bearing 84 to permit easy rotation of port plate 70 by the manipulation of wheel 74. Shaft 22 is sealed at the left-hand end of the housing by a gasket or other suitable sealing structure 86, and shaft 76 is sealed by a gasket 88 and externally threaded nut 90 disposed in a threaded recess in the external surface of section 16.

The Gerotor element 46 is provided with radial passages 91 extending inwardly from the space between the teeth and containing check valves 92 which permit the fluid to escape from the space between the teeth inwardly to lateral passage 94 on the side of element 46 and thence to an annular collector passage 96 in section 14. Each check valve 92 consists of a ball 98 and an insert 100 having a port 102 therethrough over which the ball seats. The insert is held in place by a retainer ring 104 seated in an annular slot in the side wall of passage 90. The ball which is urged toward its seat by a coil spring 106, is unseated to permit fluid to flow from the space between the teeth of element 46 when those spaces from the discharge or contracting chambers 54. Annular passage 96 communicates with outlet passage 110 in housing section 14, which in turn is connected to a hydraulic line to the inlet of the motor being driven by the present pump. The check valves are only operable during the discharge stroke and only when the position of arcuate passage 72 of port plate 70 is not in communication with the contracting chambers.

In the operation of the present pump, rotation of shaft 22 in the counter clockwise direction, as viewed in FIGS. 5 and 6, draws hydraulic fluid inwardly through inlet passages 60, 62 and 64 to the expanding chambers 52 between the two Gerotor elements. The two elements rotate in the same direction with the outer element being driven by the inner element as a result of the intermeshing internal and external teeth of the outer and inner element, respectively. The intake chambers 52 filled with the fluid pass the lower point of the cavity, as viewed in FIG. 5, and become contracting chambers 54, and the fluid in the contracting chambers is forced therefrom through check valve 92 into annular passage 96 and discharge passage 110 from where it is delievered by the hydraulic line to the intake of the hydraulic motor being driven by the pump.

The amount of fluid is varied in accordance with the power output requirements of the motor by varying the angular position of arcuate slot 72 in rotatable port plate 70. In the form illustrated, the arcuate slot is moved to an angular position in communication with only a portion of the contracting chambers 54, thus permitting the chambers unconnected to slot 72 to deliver their full capacity through the respective check valves and to outlet passage 110. The lower end of arcuate passage 72, as viewed in FIG. 5, is moved to the desired position to obtain the required pump outlet flow. When the contracting chambers reach the lower end of arcuate slot 72, the fluid immediately passes from the contracting chambers through the slot and hence to passage 66, and either to the reservoir or to the inlet passage 64. Thus, by varying the angular position of slot 72, the effective capacity of contracting chambers 54 is varied from full capacity to zero capacity. If the requirements of the pump are minimal, the port plate is rotated to place the arcuate slot where the lower end communicates with the contracting chambers at a point near the start of the discharge, thus preventing the contracting chambers from delivering fluid through check valves 92 to the outlet passage 110. The position of arcuate slot 72 is readily varied by rotating wheel 74, which in turn rotates shaft 76, extension 78 and thus port plate 70. The position of slot 72 alone controls the effective capacity of contracting chambers 54 and can be adjusted between full and zero capacity at any time during the operation of the pump by merely rotating the adjustment wheel 74.

Variations in structure may be made in the pump, including the arrangement illustrated in FIG. 8 in which the check valve 92' is placed in the outer Gerotor element 42' between the teeth thereof. An annular outlet passage 96' identified by a broken line forms the collector for the fluid passing through the various check valves and delivers the fluid to outlet passage 110. The pump having the modification illustrated in FIG. 8 is essentially the same as the pump disclosed in FIGS. 1 through 7. In a further modified form, arcuate slot 72 is adjusted to communicate with the contracting chambers at the start of the contracting operation to bleed off the fluid in excess of the desired delivery, permitting the chambers to complete the pressurizing function near the conclusion of the contracting operation. In either arrangement, the position of the arcuate slot in port plate 70 is controlled by wheel 74 in essentially the same manner to vary the effective capacity of the discharge chambers 54.

The embodiment of the invention illustrated in FIGS. 9 and 10 involves a vane type positive displacement pump consisting of a ring 122 having a vane track 124 on its internal wall. The particular pump illustrated is a dual pulse pump having intake chambers 126 and 126' which receive fluid from inlet passage 127, and outlet chambers 128 and 128' which deliver fluid to outlet passage 129. The rotor 130 is mounted on a shaft 132 eccentric with the pump cavity, and contains a plurality of vanes 134 and vane slots 136 equally spaced around the periphery of the rotor and urged to seat at their outer edges on the vane track 124. Disposed between each of the vanes is an outlet passage 140 having a check valve 142 therein of a construction similar to the check valve used in the previous embodiment. Passage 140 is connected to a lateral passage 144 which in turn is connected to an annular passage 146 and thence to outlet passage 129. A port plate 150 similar to the port plate of the previous embodiment contains an arcuate slot 152 which communicates with the contracting chambers. Since this is a dual pulse pump, two arcuate slots on opposite sides of the port plate are provided for the respective contracting chambers. Port plate 150 is rotated to various angular positions by a shaft and wheel similar to the

previous embodiment, and is adjusted to vary the effective capacity of the discharge chambers by returning a portion of the fluid either to the pump inlet or the reservoir from the chambers adjacent the start or finish of the contracting operation. The sections **154** and **156** along with ring **122** may be assembled into a housing such as the housing **12**.

While only two embodiments of the present pump concept have been described in detail herein, various changes and modifications may be made without departing from the scope of the invention.

I claim:

1. A pump comprising a housing having walls defining a cylindrical cavity, a rotor in said cavity forming a series of expanding chambers and a series of contracting chambers around the periphery thereof, a stationary plate beside said rotor and having an inlet passage communicating with said expanding chambers and having an outlet passage communicating with said contracting chambers, said outlet passage being spaced from the center of said stationary plate and radially from said inlet passage, a rotatable port plate beside said rotor disposed on the side opposite said stationary plate and having an elongated port therein communicating with said contracting chambers, a means for rotating said port plate to various angular positions with respect to said contracting chambers for removing a portion of the fluid from said contracting chambers at certain stages in the pumping cycle and thereby varying the effective capacity of said contracting chamber, means defining passages connecting each of said contracting chambers with said outlet passage, and a check valve in each of said last mentioned passages for preventing backflow of fluid from the outlet passage to said chambers.

2. A pump as defined in claim **1** in which an internally toothed Gerotor element is disposed in said cavity and said rotor is provided with external teeth for cooperating with said internally toothed element.

3. A pump as defined in claim **2** in which the passages connecting the fluid chambers with the outlet passage are disposed between the teeth at the periphery of said rotor.

4. A pump as defined in claim **3** in which said rotor is mounted on a shaft projecting from said housing.

5. A pump as defined in claim **2** in which said port plate contains an arcuate slot communicating with the contracting chambers formed by the internal and external teeth on the two rotors, and a shaft is connected to said port plate in axial alignment with the axis of said rotor and projects from said housing, and a means is mounted on said last mentioned shaft for rotating said shaft and the port plate to vary the angular position of said arcuate slot.

6. A pump as defined in claim **4** in which said port plate contains an arcuate slot communicating with the contracting chambers formed by the internal and external teeth on the two rotors, and a shaft is connected to said port plate in axial alignment with the first shaft and projects from said housing, and a means is mounted on said last mentioned shaft for rotating said shaft and the port plate to vary the angular position of said arcuate slot.

7. A pump as defined in claim **1** in which said housing contains a passage for receiving fluid from the port in said port plate and another passage connecting said last mentioned passage with said inlet passage.

8. A pump as defined in claim **2** in which the passages connecting said chambers with the outlet passage are disposed in said internally toothed element.

9. A pump as defined in claim **1** in which said rotor includes a plurality of radially extending equally spaced vanes, passages in said rotor connecting the space between each of said vanes with said outlet passage and a check valve in each of the passages in said rotor.

10. A pump as defined in claim **9** in which said port plate contains an arcuate slot communicating with the contracting chambers formed by said vanes, and a shaft is connected to said port plate in axial alignment with the first shaft and projects from said housing, and a means is mounted on said last mentioned shaft for rotating said shaft and the port plate to vary the angular position of said arcuate slot.

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W. J. GOODLIN, Assistant Examiner

U.S. Cl. X.R.

103—126, 136; 418—167