United States Patent

Belcher

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[54] ROTARY PUMP WITH INTEGRAL ROTOR CONSTRUCTION

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[52] **U.S. Cl.** **418/186,** 418/188, 418/215, 418/15, 418/248, 418/249

[51] **Int. Cl.** **F01c 11/00,** F03c 3/00

[58] **Field of Search** 418/186, 188, 215, 210, 212, 418/213

[56] **References Cited**

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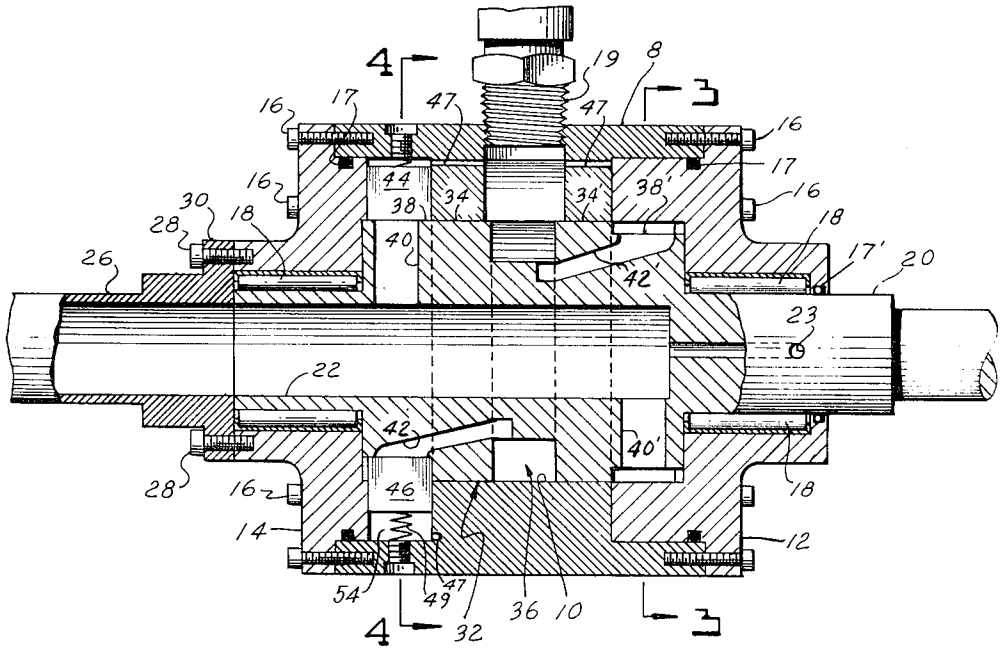
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[57] **ABSTRACT**

A rotary pump of unitary rotor construction disposed within a housing having a cylindrical inner surface. A tubular shaft extends from one end of the rotor and supplies fluid to the axis of the rotor. A pair of axially spaced cylindrical disks concentric with the shaft form with the inner wall of the housing a pump discharge chamber. A pair of cylindrical pumping cams eccentrically formed on the shaft are disposed outwardly of said cylindrical disks with the eccentricity or high point of one cam being diametrically opposite the high point of the other. A pair of radially movable gate members urged into engagement with diametrically opposed surfaces of each of said cams define with the outer surface of the cam, the housing and concentric disks four separate fluid chambers, one on each side of said gates. The gates engaged with one cam lie in a plane approximately perpendicular to a plane containing the gates engaged with the other cam. A suction port extends radially from the bore of the tubular shaft to the outer surface of each cam and a pressure or discharge port extends axially from the outer surface of each cam into communication with the annular discharge chamber disposed intermediate said cams. The suction and pressure ports of each cam are located on opposite sides of its high point and located diametrically opposite the suction and discharge ports respectively of the other cam.

5 Claims, 6 Drawing Figures



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3 Sheets-Sheet 1

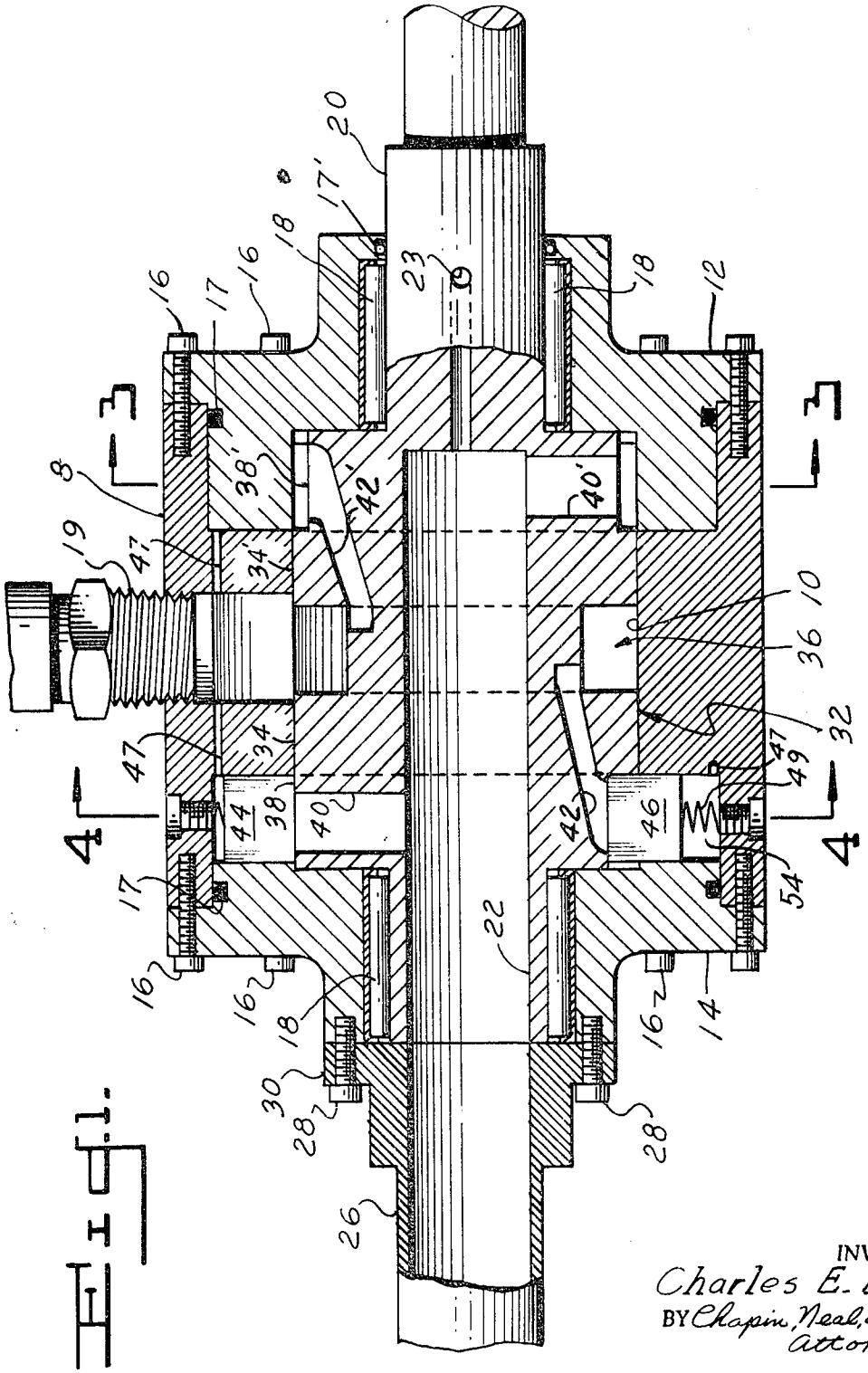


FIG. 1.

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Fig. 2.

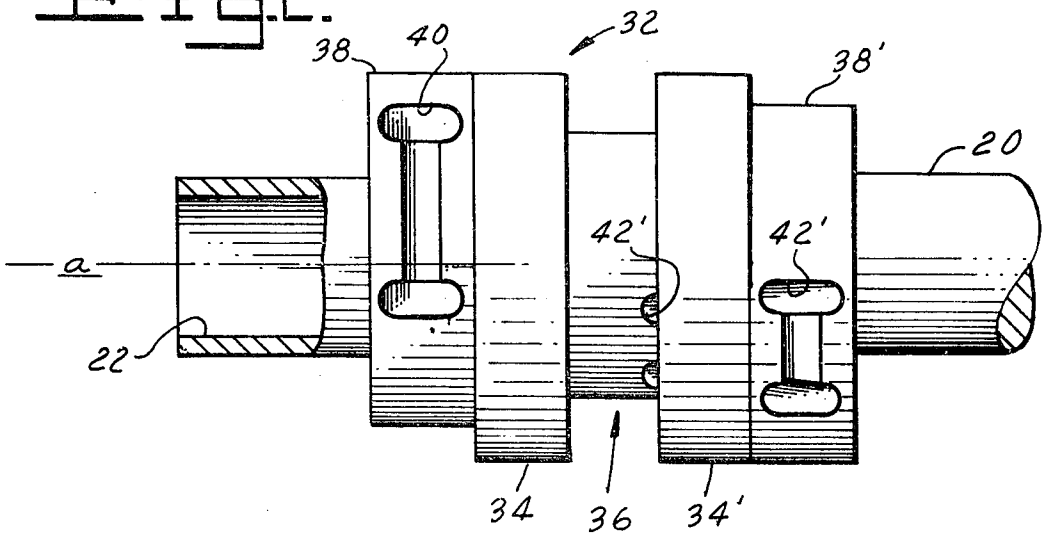
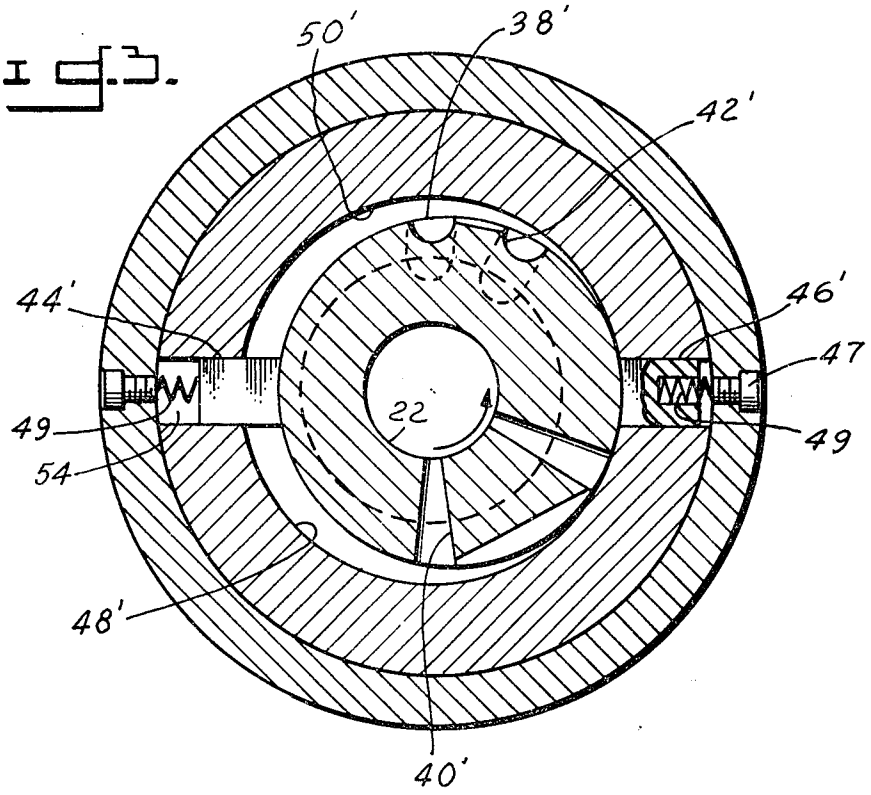


Fig. 3.



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Fig. 4.

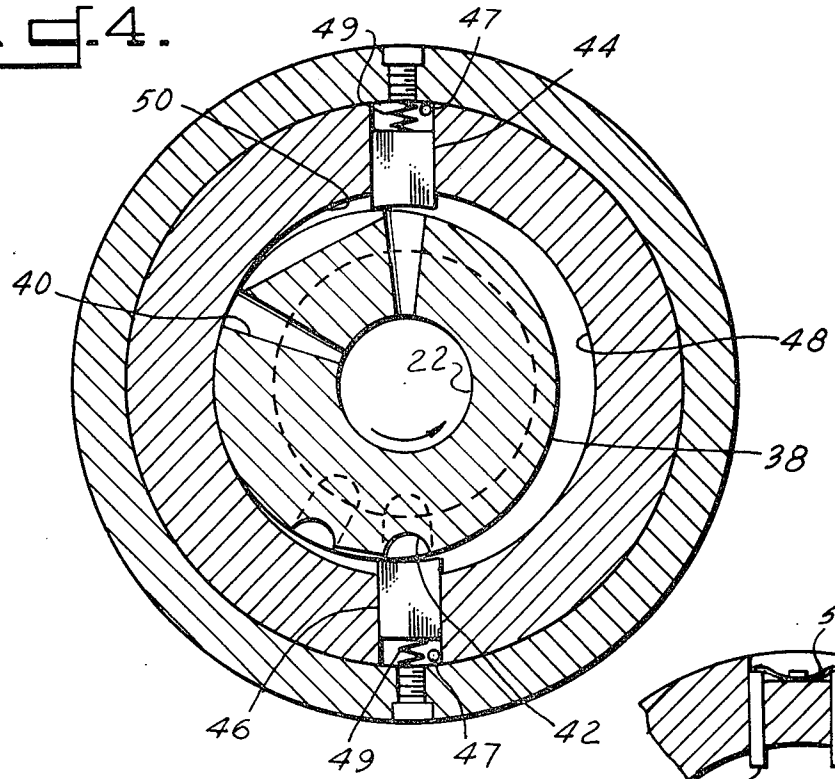
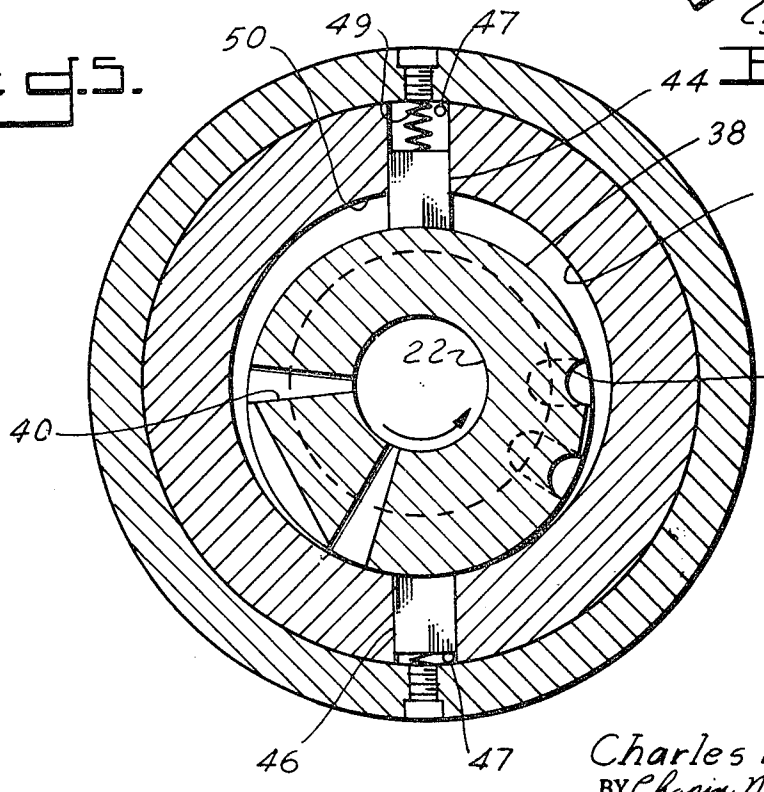


Fig. 6.

Fig. 5.



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ROTARY PUMP WITH INTEGRAL ROTOR CONSTRUCTION

BACKGROUND

The principal object of this invention is to provide a rotary pump of simple and economical construction with a minimum of moving parts, which is capable of achieving uniform and high volume output.

Another object of this invention is to provide a rotary pump having a rotor of unitary construction capable of being driven clockwise or counterclockwise.

A further object of this invention is to provide for a rotary pump a rotor constructed to minimize axial thrust and to minimize wear on the pump bearings.

The above and other objects of this invention will be more readily apparent from the accompanying description and with reference to the accompanying drawings, in which:

FIG. 1 is a cross sectional view showing a pump embodying this invention;

FIG. 2 is an elevational view showing the rotor portion of the pump;

FIG. 3 is a sectional view along line 3—3 of FIG. 1;

FIG. 4 is a sectional view along line 4—4 of FIG. 1;

FIG. 5 is a view similar to FIG. 4 but with the rotor turned to a different operative position; and

FIG. 6 is a partial view showing an alternative form of gate construction.

Referring in detail to the drawings, in the illustrated embodiment the pump embodying this invention comprises a housing **8** having an inner cylindrical surface **10**. The opposite ends of the housing are closed by a pair of end caps **12** and **14** secured to the housing by any suitable means, such as circumferentially spaced bolts **16**. O-rings **17** are provided between the housing of the pump and the end plates to provide a fluid seal and an outlet or discharge tube **19** extends from the housing at approximately the midpoint of its length. Each of the end caps includes a roller bearing **18** which supports at one end of the pump the drive shaft **20** and at the other end a bore or tubular fluid supply conduit **22**. A small bleed off passage **23** is provided to relieve fluid pressure from the end seal **17'** to the suction or low pressure side of the pump rotor. A tubular supply conduit **26** communicates in end-to-end relation with the conduit **22**. As shown, the conduit **26** is connected to the pump by means of a number of bolts **28** circumferentially spaced about a flange **30** which extends radially outward of the inner end of the conduit. While in the embodiment shown, the rotor is integral, it is within the scope of this invention to provide a spline connection between the drive shaft **22** and the tubular conduit of the rotor so that the drive end can be connected to either end of the rotor for use in pumps rotatable in a direction opposite the direction shown.

A unitary rotor, shown generally at **32**, FIGS. **1** and **2**, comprises at approximately the center thereof a pair of axially spaced cylindrical disks **34** and **34'** concentric with the axis *a* of the rotor as shown in FIG. **2**. An annular recess **36** is disposed between the opposed surfaces of the disks **34** and **34'**, and together with the inner wall and the housing forms a discharge chamber **36** for the pump with which a discharge passage or fitting **19** communicates. The diameter of the cylindrical disks **34** and **34'** is made of such clearance relative to the inner wall of the pump housing that the high pressure discharge liquid is capable of forming a thin film between the outer surface of the disks and the housing so that a thin liquid film supports the rotation of the rotor and thus minimizes wear on the bearings **18**.

Extending axially from the outer surface of each of the concentric disks **34** and **34'** is a pumping cam **38** and **38'**, respectively. Each of the pumping cams **38** and **38'** is of cylindrical configuration of smaller diameter than the disks **34** and **34'** and arranged eccentrically relative to the axis *a* of the rotor shaft. The radius of the cams is less than the radius of the disks by the eccentricity such that the outermost surface portions or

high points of the pumping cams and the cylindrical disks **34** and **34'** are generally flush over a small arc of about 5°–10° of their circumference. The eccentricity or high points of the two cams extends in diametrically opposite directions, as shown in FIG. **2**. The diameters of the two pumping cams **38** and **38'** as indicated are smaller than the disks **34** and **34'** so that when the rotor is disposed within the cylindrical housing **8**, a chamber covering an arc of approximately 350° is formed about the periphery of each of the cams from its high point. The bore **22** extends coaxially within the rotor from its inlet end at the conduit **26** to a point within the pumping cam **38'** so as to supply fluid to both pumping cams in the manner to be described below. The axial length of the cams and dimensional relationship of cam size to disk size are selected to achieve a desired pump displacement.

Each cam has a suction port **40** and **40'**, respectively, extending radially from the tubular conduit **22** through the outer surface of the cams. The suction ports are located at an acute angle following, in its direction of rotation, the high point of the cam. Suction ports **40** and **40'** are located on diametrically opposite positions of the rotor (FIG. **1**). Each cam is also provided with a pressure or discharge port **42** and **42'** extending axially inwardly so as to provide a fluid passage to the annular discharge chamber **36** from the rims of the respective pumping cams **38** and **38'**. The discharge ports are located at an acute angle in advance, in its direction of rotation, of the high point of each cam. The pressure ports **42** and **42'** are also located on diametrically opposite sides of the rotor. In the embodiment shown, each port comprises two adjacent, radially extending orifices interconnected by a chordal passage to provide the desired quantity of fluid flow.

A pair of gates **44** and **46** are engaged with diametrically opposite surface portions of cam **38**, and gates **44'** and **46'** are similarly disposed to engage cam **38'**. The gates **44** and **46** engaged with one cam, lie in a plane generally perpendicular to the plane containing the outer gates **44'** and **46'** and are hydraulically retained in surface-to-surface contact with the outer surface of the cams as by means of a small passageway or conduit **47** which extends from the discharge connection **19** into chambers **54** above the gates **44** and **46** and **44'** and **46'**. The fluid urges the gates into surface-to-surface contact with the rims of the pumping cams. In addition, springs **49** urge the gates inwardly against the cams rims while the pump is being started and before it has developed full pressure. Once the pump is in full operation the force exerted by the fluid itself is sufficient to maintain the gates in operating contact with the pumping cams.

An alternate form of gate instead of the unitary block construction heretofore described is shown in FIG. **6** and comprises a pair of laterally spaced plate or blade members **51** urged inward by leaf spring **53**. The blade members are independently movable and operable hydraulically in the same manner as the gates **44** and **46** but with much less area of contact with the rotor pumping cam.

As best seen in FIG. **3**, in which the gates **44'** and **46'** are shown engaged with the high and low points of the cam **38'**, the gates divide the peripheral chamber about the two pumping cams into two separate chambers **48'** and **50'** for cam **38'** and chamber **48** and **50** for cam **38** (FIGS. **4** and **5**), each covering an arc of about 170°, allowing approximately 10° for the surface engagement of the cam's high point and pump wall. As the cam rotates in the direction shown, from its FIG. **3** position, the volume of chamber **50'** diminishes to force the fluid contained therein through the discharge port **42'** and into the annular chamber **36**. At the same time chamber **48'** increases in volume at the same rate as the chamber **50** decreases to create a suction which draws fluid into the chamber through the suction port **40'**. Suction continues to fill the camber until the suction port has rotated past the gate **46**. When this happens, as shown for cam **38** in FIG. **4**, the two chambers **48** and **50** reverse functions; chamber **50** becoming the suction chamber and **48** the discharge chamber.

In the position illustrated by FIG. 4, the chamber **48** has just been filled with the fluid being pumped. Continued rotation of the cam **38** from this position will bring the discharge ports **42** into the chamber **48**, as shown in FIG. **5**. At the same time, chamber **50** starts filling with fluid in a suction cycle. Thus, for one revolution of each pumping cam, two suction and two discharge cycles take place. Both pumping cams operate in essentially the same manner except that one is 180° out of phase with the other. The reason for this is that the discharge and suction ports are located on diametrically opposite positions on the rotor as is the high point of the cam. In addition, as mentioned previously, the line along which gate members **44'** and **46'** operate is approximately perpendicular to the line along which gates **44** and **46** operate. Thus, in one rotation of the rotor there is an overlap of approximately 90° in the suction and discharge cycles. That is, one cam starts its suction and discharge cycles 90° in advance of the corresponding cycles of the other cam. This insures smooth, nonsurging output from the pump.

When fluid is forced into the ports **42** and **42'** leaving from the two pumping cams, it is forced into the annular chamber **36** in opposite directions, thus resulting in substantial balance of axial thrust on the rotor. The fluid is discharged from annular chamber **36** through the discharge coupling **19**.

Having thus disclosed my invention, what is claimed is:

1. A rotary pump comprising a housing with a rotor rotatably supported therein, said rotor having a shaft of tubular construction serving as a fluid supply conduit for said pump, said rotor including axially spaced pumping cams eccentrically disposed about said shaft with an annular discharge chamber therebetween, each of said cams including a suction port extending from said conduit to the rim of said cam and a discharge port extending from said rim to said discharge chamber, and a pair of radially movable gate members urged into engagement with the diametrically opposed surfaces of each of said cams.

2. A rotary pump as set forth in claim **1** in which the eccentricity of each of said cams extends in diametrically opposite directions, and in which the discharge and suction ports of one cam are disposed diametrically opposite the discharge and suction ports respectively of the other cam.

3. A rotor pump as set forth in claim **2** in which said rotor is of integral construction

4. A rotary pump as set forth in claim **3** in which said rotor includes a pair of axially spaced cylindrical disks concentric with said shaft and defining with the inner wall of the pump housing said annular discharge chamber, said pumping cams being of cylindrical configuration extending in height axially from the outer surface of said disks and of a radius less than the radius of said disks by the extent of eccentricity of said cams, said pumping cams being concentrically disposed on said shaft so that the rim of each cam, at it high point, is generally flush with the rim of the adjacent disk over a small arc of the circumference of said disk, said discharge ports being disposed forwardly of the high point of said cam, in its direction of rotation, and said suction ports trailing said high point, in its direction of rotation, said disks, gate members, pump housing and rims of said cams providing about each cam a pair of fluid chambers which alternately serve as pumping and suction chambers during rotation of said rotor within said housing.

5. A rotary pump comprising a housing with a generally cylindrical inner surface, a shaft supported rotor disposed within said housing, said rotor comprising axially spaced cylindrical disks concentric with said shaft and forming with the inner wall of the pump housing an annular discharge chamber, a pair of cylindrical pumping cams of smaller diameter than said disks eccentric with respect to said shaft such that the eccentricity of each extends in diametrically opposite directions, said shaft being tubular in part to provide a fluid passage therein, each cam including a suction port extending radially from said fluid passage to the rim of said cam and a discharge port extending from the rim of each of said cams into communication with said annular discharge chamber and a pair of radially movable gate members urged into engagement with diametrically opposed surfaces of each of said cams, the discharge ports being located forward of the high point of said cams in their direction of rotation and on diametrically opposite sides of the rotor, said suction ports trailing said high points and on diametrically opposite sides of the rotor, and a discharge opening in said housing communicating with said discharge chamber.

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