United States Patent [19]

Daido

[11] **3,726,617**

[45] **Apr. 10, 1973**

[54] **PUMP OR A MOTOR EMPLOYING A COUPLE OF ROTORS IN THE SHAPE OF CYLINDERS WITH AN APPROXIMATELY CYCLIC SECTION**

[76] Inventor: **Takayoshi Daido,** 624 Jippoji, Himeji, Japan

[22] Filed: **Apr. 9, 1971**

[21] Appl. No.: **132,776**

[30] **Foreign Application Priority Data**

Apr. 17, 1970 Japan 45/33198

[52] **U.S. Cl.**...................................**418/150,** 418/204

[51] **Int. Cl.**............**F01c 1/24,** F03c 3/00, F04c 1/14

[58] **Field of Search**...............................418/204, 150

[56] **References Cited**

UNITED STATES PATENTS

20,796	7/1858	Holly	418/204
1,771,863	7/1930	Schmidt	418/204
1,837,714	12/1931	Jaworowski	418/204
3,078,807	2/1963	Thompson	418/204

FOREIGN PATENTS OR APPLICATIONS

696,469	9/1940	Germany	418/204
624,371	9/1961	Italy	418/204

Primary Examiner—Allan D. Herrmann
Attorney—Sparrow & Sparrow

[57] **ABSTRACT**

A pump or motor having two rotors of a defined shape such as to ensure contact between the two rotors in all positions.

1 Claim, 6 Drawing Figures

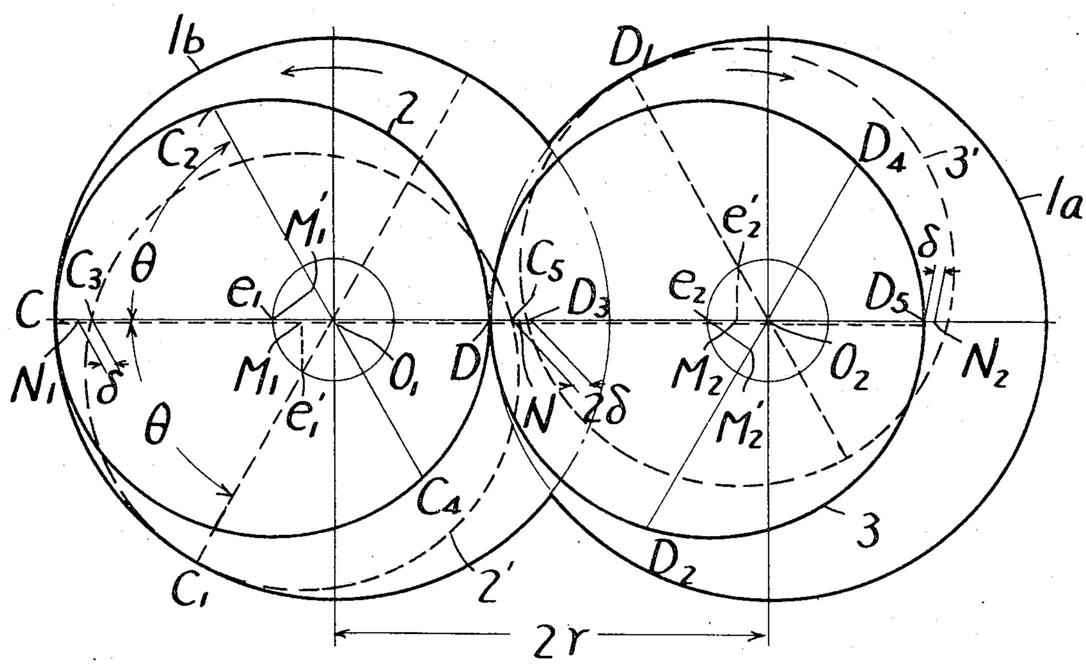


Fig. 1

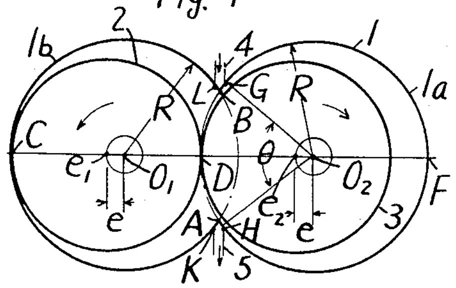


Fig. 3

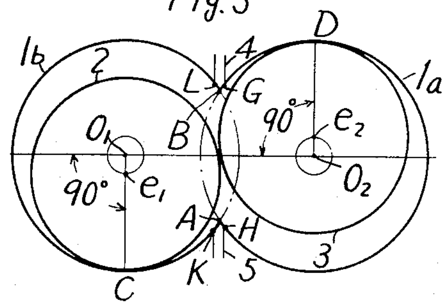


Fig. 2

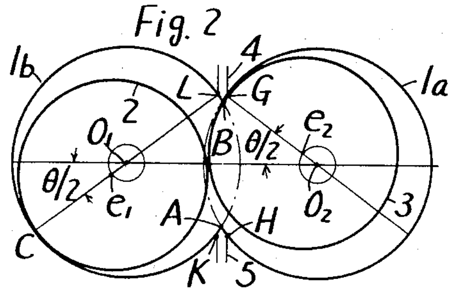


Fig. 4

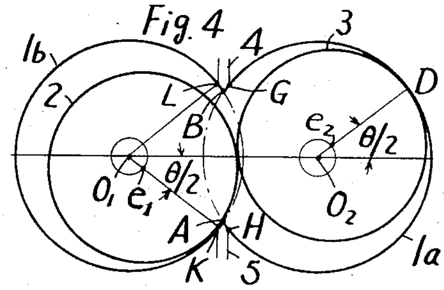
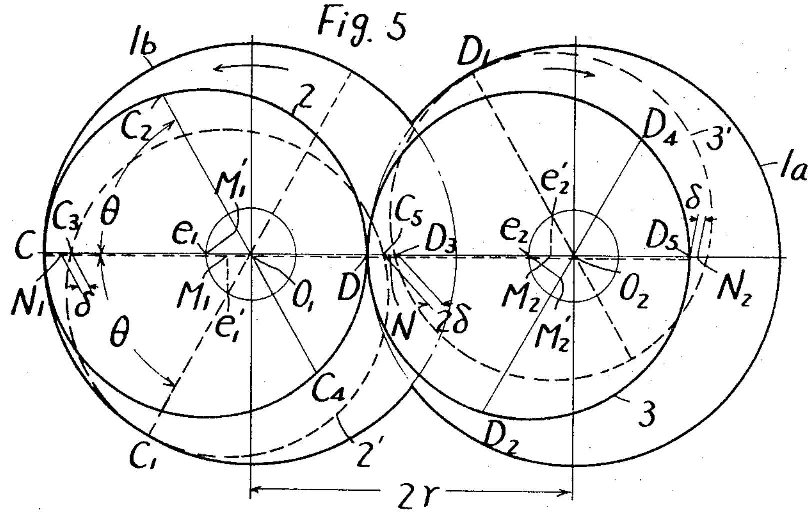


Fig. 5



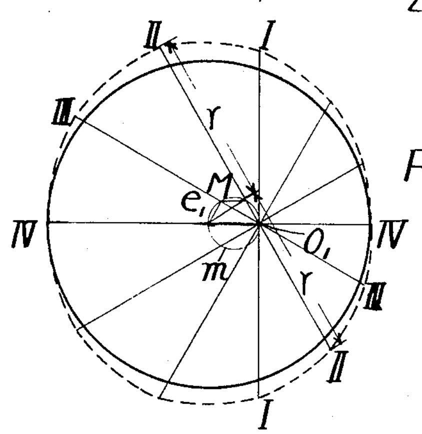


Fig. 6

INVENTOR.

Takayoshi Daido

BY

Sparrow and Sparrow

ATTORNEYS

PUMP OR A MOTOR EMPLOYING A COUPLE OF ROTORS IN THE SHAPE OF CYLINDERS WITH AN APPROXIMATELY CYCLIC SECTION

This invention relates to a pump or a motor with two cylindrical rotors having an approximately cyclic section fitted in a casing formed by the inner circumferences, excepting the crossing part, of two parallel cylinders with equal diameters made partially to intersect each others.

In the accompanying drawings,

FIGS. 1 to 4 are illustrations of this invention,

FIGS. 5 and 6 are to show the modification of the rotors.

Numeral 1 denotes the section of the inner circumference of the casing, the distance between the centers O_1 and O_2 being $\overline{O_1O_2} = 2\ (R-e)$, consisting of two circular arcs of two circles 1*a* and 1*b* with equal radius R excepting those included between A and B which are crossing points. Numerals 2 and 3 are two rotors each with eccentricity $_1$ or e_2 of eccentric radius *e* as its center and with cylindrical circumference of radius $r = R - e$. In FIG. 1, the eccentricities e_1 and e_2 are on the straight line O_1–O_2 and its extension, the rotor 2 touches the circle 1b with the center O_1 at the point C and the rotor 3 touches the circle 1*a* with the center O_2 at the middle point D of the imaginary circular arc between A and B corresponding with the cut-off portion. With the chosen size of the internal diameter of the casing and of the external diameter of the rotor, the rotors 2 and 3 naturally touches each other externally at D. Numerals 4 and 5 denote an inlet or an outlet port of working fluid and their crossing points as shown in the figure of the inner circumferences 1*a* and 1*b* of the casing are denoted by G, H, K and L.

In the above case, it is supposed that the eccentric radius e and the eccentricity *e*/*R* being chosen sufficiently small, the circular arc between G and H, which are the crossing points of the inlet or the outlet port of the working fluid shown in FIG. 1 and the inner circumference 1a of the casing, within the limits of the angle θ involved at the center O_2, is considered approximately equal to the circular arc of the rotor with the center e_2 within this angle θ and that the angle θ is a small one at least less that 90°. If the rotors 2 and 3 respectively with O_1 and O_2 as their center are made to revolve at a uniform speed in the directions of the arrows in oppositions to each other, when they revolve 90° from the above and reach the positions shown in FIG. 3, there arises a small gap between the circumferences of the rotors 2 and 3, but they go on revolving nearly keeping the state of contact with each other, and if a little modification and processing are done upon the circumferences of the rotors 2 and 3 for the purpose of stopping the gap, the working of the pump letting out the working fluid from the inlet or the outlet port 5 or contrariwise, the working of the motor by the forced working fluid can be performed.

FIGS. 2 to 4 are ones in which the states of contact of the rotors 2 and 3 in their revolving positions are examined in drawings: FIG. 2 showing when the rotors 2 and 3 are turned half of the angle degrees θ as far as radius O_2D and O_2G come together, FIG. 3 when the rotors 2 and 3 turn 90° from the positions shown in FIG. 1, and FIG. 4 when the rotors 2 and 3 turn as far as the radius O_1C and O_1K come together. Theoretically, excepting when the rotors 2 and 3 are in the positions shown in FIG. 1 and in the positions when they turn 180° from the above, there is no point of contact between them, but if a little processing is done on the circumferences of the rotors 2 and 3 so as to make them touch each other at each revolving position, leakage is practically as nothing and the working of the pump or of the motor can be performed without hindrance.

FIGS. 5 and 6 are to illustrate how to modify the circumferences of the rotors 2 and 3 in other to keep them constantly in tough with each other.

Assume that the rotor circles 2 and 3 shown in full line, with the centers O_1 and O_2 in the casings respectively as their centers of rotation, rotate at a uniform speed in the opposite directions from each other as shown by the arrows, and the points of contact C and D of the circles 2 and 3 on the casing circles 1*b* and 1*a*, each turning the angle θ, become C_1 and D_1, and while e_1 and e_2, which are respectively the cent of the circle 2 and 3, are transferred to e_1' and e_2', these circles 2 and 3 are transferred to circles 2′ and 3′ shown in dotted line. At this case, chords C_2C_4 and D_2D_4 of the circles 2 and 3 shown in full lines at the symmetrical positions with the lines O_1–C_1 and O_2 –D_1 to the straight line passing through the center O $_1$ and O_2 turns to fall on the straight line passing through the center O_1 and O_2 and the new positions are respectively shown with dotted lines C_3–C_5 and D_3–D_5. There is a small gap between C_5 and D_3 d when this gap is assumed to be 2δ, the length δ is added to each end of the chords C_3–C_5 and D_3–D_5, thus forming N_1–N and N_2–N as shown in the figure. When N_1 and N assumed to be the modified points of the rotor 2 and N_2 and N to be those of the rotor 3, both rotors 2 and 3 constantly externally touch each other at the point N. However,

$$O_1O_2 = 2r = O_1N + NO_2 = M_1N - O_1M_1 + NM_2 + O_2M_2 = M_1N + NM_2$$

and as it is obviously understood with each from the illustration that $N_1N = NN_2 = 2M_1N = 2M_2N$ if it is assumed,

$$N_1M_1 = M_1N = NM_2 = N_2N_2 = r,$$

the rotors 2 and 3 can be made to rotate with the centers O_1 and O_2 of the casings as their centers of rotation, keeping constantly in touch with each other. FIG. 6 shows how to produce an illustration making use of the above explanation in which it is sufficient, describing a circle m with the diameter of a segment of the line D_1–e_1 between the center O_1 of the casing with the center e_1 of the rotor and optional straight lines, I–O_1–I, II–O_1–II . . . all running through the point O_1 to take up the points on either side a length *r* distant from *M's* which are points of intersection where these straight lines cross the circumference of the circle *m*. (In this figure, M is identical with O_1 in the case of I–O_1–I and in case of IV–O_1–IV running on the line e_1 and O_1, e_1 is identical with M).

And in FIG.6, in case the point O_1 is the origin of co-ordinates, the x axis of co-ordinates is plus on the right side of the straight light O_1–IV from the origin and the *Y* axis of co-ordinates is plus on the upper side of the straight line O_1-I from the origin and $\overline{O'e'} = e$, the point of the modified circle is represented by

$$x = \cos\theta\,(r \pm e\cdot\cos\theta)$$

$$y = \sin\theta\,(r \pm e\cdot\cos\theta).$$

One of the characteristics of the present invention is that to lessen the pulsating flow of the working fluid, more than one sets of rotor and casing having the same rotor shaft in common but 90° different in position from each other are arranged, in which the inlet or the outlet ports **4** and **5** are joined in series so as to drive the rotors with a single motive power or contrariwise, to drive a single load by means of more than one sets of rotors. Another merit of this invention is that compared with the pumps of other types e.g. the plunger pumps or the screw pumps, this invention is remarkably simple in structure and can be provided cheaply. It is another merit of this invention that regardless of the number of rotation, the pump or the motor can produce high pressure, making no noises.

What I claim:

1. In a pump or motor having (a) a pair of chambers the inner surface of which corresponds to the nonoverlapping surfaces of two parallel and equal intersecting cylinders, (b) an inlet port and an outlet port on the two lines of intersection of said chambers, and (c) a rotor mounted in each chamber for eccentric rotation

therein about the longitudinal centerline of said chamber, the improvement comprising

a rotor of modified circular cross-section and otherwise cylindrical shape, the outer surface of said rotor in cross-section being defined by the loci of points having coordinates on an *x*-axis equal to $\cos\theta\,(r \pm e\cdot\cos\theta)$ and on the *y*-axis equal to $\sin\theta\,(r \pm e\cdot\cos\theta)$ where:

r is equal to $R-e$;

R is the radius of the cylindrical chamber;

e is the distance from the center of the rotor to the center of the rotor's eccentric rotation;

θ is the angle measured at the center of eccentric rotation of any given point on the surface of the rotor above the line intersecting the center of the rotor and the center of eccentric rotation;

said *x*-axis corresponding to a line perpendicularly intersecting the two longitudinal centerlines of the cylindrical chamber; and

said *y*-axis corresponding to a line perpendicularly intersecting both said x-axis and the centerline of said cylindrical chamber in which the rotor is disposed.

* * * * *