

⑩



Europäisches Patentamt

European Patent Office

Office européen des brevets

⑪ Publication number:

0 187 148
B1

⑫

EUROPEAN PATENT SPECIFICATION

④⑤ Date of publication of patent specification: **23.05.90**

⑤① Int. Cl.⁵: **F 01 C 1/44**

②① Application number: **85902631.2**

②② Date of filing: **03.06.85**

⑧⑧ International application number:
PCT/IT85/00005

⑧⑦ International publication number:
WO 86/00370 16.01.86 Gazette 86/02

⑤④ **Rotary machine.**

④③ Date of publication of application:
16.07.86 Bulletin 86/29

④⑤ Publication of the grant of the patent:
23.05.90 Bulletin 90/21

⑧④ Designated Contracting States:
AT BE CH DE FR GB IT LI LU NL SE

⑤⑥ References cited:
FR-A-1 376 285
FR-A-2 235 268
FR-A-2 493 397
GB-A- 26 118
GB-A- 789 375
US-A-3 295 505
US-A-3 387 596

**I. Contiero, L. Beghi, "Class of algebraic curves
passing through cyclic points" 16.03.85, p. 15
(published privately by I. Contiero and L. Beghi)**

⑦③ Proprietor: **CONTIERO, Italo**
Via Lungargine 3
I-35010 Cadoneghe (Padova) (IT)

⑦② Inventor: **CONTIERO, Italo**
Via Lungargine 3
I-35010 Cadoneghe (Padova) (IT)

Note: Within nine months from the publication of the mention of the grant of the European patent, any person may give notice to the European Patent Office of opposition to the European patent granted. Notice of opposition shall be filed in a written reasoned statement. It shall not be deemed to have been filed until the opposition fee has been paid. (Art. 99(1) European patent convention).

Courier Press, Leamington Spa, England.

EP 0 187 148 B1

Description

This invention relates to a rotary machine which exploits inner cyclic variable volumes. Such an engine as described in the preamble of claim 1 is shown in FR—A—2 235 268. The rotary machine according to the invention is composed of:

- one stator with one inner cavity U with perimetral surface M;
 - one transmission shaft, with axis of rotation Y_c linked to
 - one rotor with its longitudinal axis of rotation Y_o parallel or coinciding with axis Y_c .
- The rotor is composed of N_r sides ($N_r \geq 1$) which have N_e equal ends with equal surfaces E.

Rotor surfaces E have longitudinal axes Y_i ($i = 1$ to N_e) orthogonally intersecting a reference plane Γ at points P_i .

The intersection lines of N_e surfaces E with plane Γ are N_e equal circles or radius r with centres P_i which are points of respective axes Y_i .

Points P_i run on a curve R^N which characterises the rotary machine, as in the Wankel engine, the geometry of which is based on a curve R^N , which is a trochoid curve.

Perimetral surfaces M or stator cavity U is the external envelope of the rotor surfaces E, which slide round touching surface M along N_e equal lines.

The rotor may have either an open or closed structure either with or without hinges and may travel less than 2π with alternative rotation, provided that: $N_r + 1 = N_e \leq 2(N_r - 1)$. Between stator and rotor are defined chamber/s V of variable volume, plus another chamber Z inside the rotor.

Referring to the trajectories of rotor points P_i of the machines cited in International Search Report PCT/IT 85/00005, and to the Wankel engine, the present invention has rotor points P_i running on trajectories R^N different from the above trajectories and described in claim 1.

The present invention can work as a pump, compressor, motor, engine, valve, distributor or hydraulic joint; it may burn fuel for heat and/or electricity as in magneto-hydrodynamic generators; it can also be used as a compressor and/or booster for thermic motors with inner reactive combustion. Some applications of the present invention are now described by means of unrestrictive examples, with reference to the accompanying drawings. All the figures are drawn by the orthogonal projection system. Plane Γ , which in all cases is the reference plane, is either the plane of projection or that of the cross-section. Plane Γ is orthogonal to axis Y_c . All machines are shown without stator bases.

Figure 1 shows a generic type of machine in which axes Y_o , Y_c are distinct and parallel. The machine has a four-sided rotor $N_r = 4$; $N_e = N_r$.

Figure 2 shows a machine with a six-sided rotor ($N_r = 6$; $N_e = N_r$) and an inner stator contour M with three lobes; axes Y_o , Y_c coincide.

Figure 3 shows a machine with a four-sided rotor ($N_r = 4$; $N_e = N_r$) and an inner stator contour M with two lobes; axes Y_o , Y_c coincide.

Figure 4 is a schematic drawing of a two-stroke engine composed of two machines of the type shown in Figure 3.

Figure 5 shows rotoid curve R^N with the property of invariant length $\overline{W}$.

Figure 6 shows a machine with a rotor composed of cylinders only.

In all the figures capital letters M and E indicate the contours of cross-sections of respective surfaces M and E.

Referring to Figures 1, 2, 3 and 6, a compressor-pump of the cyclic volume machine type will now be described.

Stator body 1 has an inner cavity with perimetral surface M. Transmission shaft 14 has rotary axis Y_c which intersects plane Γ orthogonally at point C.

Rotor points P_i ($i = 1$ to N_e) run on a trajectory R^N which has the property of constant length $\overline{W}$, $\overline{W} = \overline{P_i P_{i+1}}$; each rotor side is composed of one oscillating piston 5 between two hinge cylinders or disks 4.

The rotor touches contour M by interposed rings 10 of radius r . Cylinders 4 and rings 10 have common axis Y_i . An non-extensible connection (bar 7) joins pivot/s 6 centered in points D with transmission shaft 14 (Figures 2 and 3).

Rotor sides or pistons 5 have equal height, their flat bases are parallel to plane Γ and slip over the stator bases.

External surface 9 of each piston 5 corresponds to one rotating chamber V.

Chambers V retain variable volumes $V_{(a)}$ which vary from a maximum V_M to a minimum V_m turning through a fixed number N of stator chambers 8 where $V_{(a)} = V_M$ and N chambers 11 where $V_{(a)} = V_m$. Integer N is modulus of curve R^N .

Fluid/s enter chamber/s V through valve 3 and are discharged, compressed, through valve 12 (valves are not shown in figures). Each chamber V is defined by piston wall 9, two surfaces E of rings 10, cylinder M, and two stator bases.

N_r pistons 5 form one chamber Z of variable volume $Z_{(a)}$.

Chamber Z is defined by N_e surfaces 13 of pistons 5, N_e surfaces E or rings 10 and the two stator bases; it pumps a fluid which enters and exits through holding valves (not shown in figures). Volumes $V_{(a)}$ and $Z_{(a)}$ are defined in any position of the rotor. The fluid in chamber Z cools and lubricates the machine and may feed a hydraulic accumulator (not shown in figures).

EP 0 187 148 B1

The rotor can be made by packing thin metal sheets together. It may also be an open prismatic structure, and composed of only one side without hinges, or composed of solid cylinders only. Chambers V and Z may be interconnected.

However, none of the machines shown in Figures 1, 2, 3, 4 and 6 are restrictive cases of the present invention.

Figure 4 shows a schematic view of a coaxial cyclic volume machine composed of one rotating cyclic volume machine as a compressor, and one rotating cyclic volume machine as an engine, with one common transmission shaft 14 and one common stator base between them. Operating fluid enters 3 and flows through the two transfer channels 23 bored in the common base, and is controlled by engine rotor $P_1 P_2 P_3 P_4$.

The fluid enters the two opposite combustion chambers, where it is further compressed for combustion. Waste gases are discharged through channels 24 bored in the stator base of the engine side. Maximum fluid compression occurs in engine area 11, where ignition takes place and expansion of gases rotates the polygonal structure of the engine and the compressor. In this example, it is assumed that cooling fluid enters the Z area of the compressor, passing through the Z area of the engine, and powers a hydraulic accumulator which is also a heat radiator (not shown). Axes X_1 and X_2 form angle β on projection plane. Angle β is important for precompression of the engine when the axis of channel 23 is parallel to axis Y_C .

With appropriate configuration of the discharge channels, thrust from waste gases may be exploited to produce a jet action. Referring to all the Figures, points $P_1, \dots, P_{N_e}$ run along plane trajectory R^N , which has modulus N, $N \geq 2$; N is a fixed integer. Points P_i $i = 1$ to N_e maintain constant reciprocal distance $\bar{W}$, (i.e., curve R^N is the trajectory of the N vertices of the equilateral family of polygons $P_1 \dots P_N$ of side length $\bar{W}$:

$$\bar{W} = \overline{P_1 P_2} = \dots = \overline{P_N P_1}$$

$\bar{W}$ is the length of one or plus segments $\overline{P_i P_{i+1}}$ which rotate and translate with respect to pole C).

Modulus N conditions the choice of the maximum number N_r of rotor sides $1 \leq N_r \leq N$ which have number N_e of equal cylindrical ends E; $2 \leq N_e \leq 2(N_r - 1)$.

Cylindrical surfaces E have axes Y_i ($i = 1$ to N_e) which intersect reference plane Γ orthogonally at points $P_1 \dots P_{N_e}$.

Rotor points P_i of the present invention run along curve R^N belonging to a new class of curves called ROTOID CURVES with the peculiar geometrical property called invariant length $\bar{W}$.

In the most general cases, these rotoid curves are defined by the mathematical law (1) quoted below and published for the first time in the booklet: "Class of algebraic curves passing through cyclic points. Invariance of length. Invariance of area. ROTOIDS" on page 15, line 17, published privately by I. Contiero and L. Beghi in Padova on 16 March 1985. This booklet has regularly been open to public inspection according to Italian law.

All curves belonging to this class are obtained by transforming one assigned plane curve L as follows. All the following reasoning expound geometric implications and the mathematical significance of the quantities represented by symbols $f_{(\alpha)}$, $W_{(\alpha)}$, $\bar{W}$ and $g_{(\alpha)}$ in formula (1).

Referring to Figure 5, let L be a simple, closed, curve on reference plane Γ .

Let the points F_i , $i = 1$ to N , lie on curve L and distributed in infinite groups of points, each group consisting of N points $F_1, \dots, F_N$, $N \geq 2$, (modulus N is constant integer). Points F_i are vertices of one equilateral N-polygon F_i with side length $\overline{F_i F_{i+1}} = W_{(\alpha)}$; $W_{(\alpha)}$ depends on anomaly α .

Axis Y_C is orthogonal to a plane Γ in a point C inside the region defined by curve L. Point C is distinct from baricentre O of N-polygon F_i .

Referring to a polar system of coordinates with pole C and polar axis X on reference plane Γ , let curve L be defined by polar equation $\overline{CF_1} = f_{(\alpha)}$.

$\alpha = F_1 \hat{C} X$ is anomaly, $0 \leq \alpha \leq 2\pi$ $f_{(\alpha)} > 0$ $f_{(\alpha)} = f_{(\alpha+2\pi)}$. L being a closed curve, function $f_{(\alpha)}$ will be defined for any value of α ; then $f_{(\alpha)}$ is a continuous function.

According to the conventional direction of positive anomalies, for any value of α at least one N-polygon F_i will exist, because L is a closed curve with $f_{(\alpha)}$ continuous.

Let L be formed so that only one equilateral N-polygon $F_1 \dots F_N$ corresponds to each value of anomaly α ; therefore, only one side length $W_{(\alpha)}$ corresponds to any α .

Let $F_1 \hat{C} F_2 = \lambda_1$, $F_2 \hat{C} F_3 = \lambda_2, \dots, F_N \hat{C} F_1 = \lambda_N$ be measures of positive angles and $\lambda_1 + \lambda_2 + \dots + \lambda_N = 2\pi$.

A system of N equalities expressed by $f, \alpha, \lambda_1, \lambda_2, \dots, \lambda_N$ is valid according to Carnot's theorem, to determine side length $W_{(\alpha)}$

$$W_{(\alpha)} = \overline{F_1 F_2} = \overline{F_2 F_3} = \dots = \overline{F_N F_1}$$

Radius vector f of curve L is then transformed into radius vector g of curve R^N which will be a rotoid according to the law:

$$g_{(\alpha)} = f_{(\alpha)} \bar{W} / W_{(\alpha)} \quad 0 \leq \alpha \leq 2\pi \quad (1)$$

in which $\bar{W}$ is an assigned constant; and as $f_{(\alpha)}$ is a continuous function, $g_{(\alpha)} = \overline{CP_1}$ will also be a continuous

EP 0 187 148 B1

function. $g_{(\alpha)}$ is excluded from defining a circle, $g_{(\alpha)} \neq \text{constant}$, by means of a convenient position of pole C and/or a suitable value of modulus N.

For each value of anomaly α , we consider one group of points $P_1, P_2, \dots, P_N$ of polar coordinates, respectively:

$$g_{(\alpha)}, \alpha; g_{(\alpha+\lambda_1)}, \alpha + \lambda_1;$$

$$\dots g_{(\alpha + \sum_{i=1}^N \lambda_i)},$$

$$\alpha + \sum_{i=1}^N \lambda_i$$

Calculation of the measures of segments $\overline{P_1 P_2}, \overline{P_2 P_3}, \dots, \overline{P_N P_1}$, according to Carnot's theorem, give equal value $\overline{W}$

$$\overline{W} = \overline{P_i P_{i+1}}$$

$$(i = 1 \text{ to } N)$$

In all cases:

if L is a closed, regular, plane curve, by means of law (1), the transformed curve R^N will also be closed and regular; and,

if L is an algebraic curve, transformed curve R^N will also be an algebraic curve.

The Kempe theorem demonstrates that algebraic curves may be drawn with continuous lines by means an appropriate system of bars.

$\overline{W}$ is the side measure of one family of equilateral N-polygons P_i . Figure 1 shows a machine in the general case: rotor axis Y_O is orthogonal to reference plane Γ in baricentre O. Baricentre O is different from pole C, Y_O/Y_C . Angles $P_i \hat{P}_{i+1} P_{i+2}$ vary with anomaly α .

Curve R_N defined by function $g_{(\alpha)}$ is therefore the trajectory of the group of running points P_i ($i = 1$ to N) which maintain constant reciprocal distance $\overline{W}$. This is the peculiar property of rotoid curves with the property of invariant length.

In the general case: rotor baricentre O has defined coordinates, and angles $\delta_i = P_i \hat{O} P_{i+1}$ depend on anomaly α .

In particular cases of moduli $N = 2, N = 3, N = 4$, baricentre O is the vertex of angles $\delta_i = P_i \hat{O} P_{i+1}$, which do not depend on anomaly α , Figure 5.

In these cases, a circle, centred on baricentre O with radius $\overline{OQ_i}$, intercepts N points $Q_i, i = 1$ to N on half-lines OP_i , Figure 5.

Points Q_i are also on a rotoid curve R^N because measures of segments $\overline{Q_i Q_{i+1}} = \overline{W}$ are constant, independent of anomaly α , $Q_i \hat{O} Q_{i+1} = P_i \hat{O} P_{i+1} = \delta_i = 2\pi/N$.

Machines with rotor vertices on points Q_i are characterized by the non-deformability of the rotor and rotoid curve R^N is defined by radius $\overline{CQ_i}$ Figure 5, angles $Q_i \hat{Q}_{i+1} Q_{i+2}$ are constant.

In the particular case of a curve L^h with h symmetry axes, L^h invariant if rotated round pole C of angle $T = 2\pi/h$, and modulus $N = 2h$; points $F_i, i = 1$ to $2h$ define, with pole C, constant angles

$$F_1 \hat{C} F_2 = F_2 \hat{C} F_3 = \dots = F_N \hat{C} F_1 = \lambda$$

$\lambda = \pi/h$ independent of anomaly α ; then:

$$W(\alpha) = \sqrt{\overline{CF_i}^2 + \overline{CF_{i+1}}^2 - 2\overline{CF_i} \cdot \overline{CF_{i+1}} \cos \lambda}$$

In these cases:

equation $g_{(\alpha)} = \overline{CP_i}$ of formula (1) defines a rotoid R^N with the property of:

$$\overline{W} = \sqrt{\overline{CP_i}^2 + \overline{CP_{i+1}}^2 - 2\overline{CP_i} \cdot \overline{CP_{i+1}} \cos \lambda}$$

points $P_i, i = 1$ to $2h$, are rotor vertices, and, with pole C, define constant angles $P_1 \hat{C} F_2 = P_2 \hat{C} F_3 = \dots$

EP 0 187 148 B1

$P_N \hat{C} F_1 = \lambda$, Figures 2 and 3. Machines characterized by these trajectories of rotor vertices have axis Y_0 coinciding with axis Y_C and with the symmetry axis of stator cavity U.

Transformation of a conical curve L defined by equation $f_{(\alpha)}$:
let ellipse L have: symmetry centre in pole C on polar axis X;

half-axis $B = f_{(0)}$; half-axis $A = f_{(\pi/2)}$.

$$f_{(\alpha)}^2 = A^2 B^2 / (B^2 \cos^2 \alpha + A^2 \sin^2 \alpha)$$

constant

$$\overline{W}_1 = \sqrt{A^2 + B^2}$$

is assigned.

By formula (1), equation $f_{(\alpha)}$ is transformed into equation

$$g_2(\alpha) = \overline{W}_1 f_{(\alpha)} / W(\alpha) \quad g_2(\alpha) = \sqrt{A^2 \sin^2 \alpha + B^2 \cos^2 \alpha}$$

Equation $g_{2(\alpha)}$ has property of invariant length:

$$\overline{W}_1 = \sqrt{g_2^2(\alpha) + g_2^2(\alpha + \pi/2)}$$

Algebraical summation of one constant a^2 with equation $g_{2(\alpha)}$ does not change the property of invariant length:

$$g_1(\alpha) = \sqrt{a^2 + g_2^2(\alpha)} = \sqrt{a^2 + A^2 - (A^2 - B^2) \cos^2 \alpha}$$

Equation $g_{1(\alpha)}$ also has the property of invariant length:

$$W = \sqrt{g_1^2(\alpha) + g_1^2(\alpha + \pi/2)}$$

Multiplicative integer n/s of anomaly α is introduced in equations $f_{(\alpha)}$, $g_{1(\alpha)}$ to define new curves L^h , R^N with $h = n$ symmetry axes:

$$g(\alpha) = A \sqrt{(p-1) + (1-q) \cos^2(n\alpha/2)} \quad (2)$$

$$p = a^2/A^2 \quad q = B^2/A^2.$$

When $n/2$ is an odd integer number ($h = 2, 6, 10, 14 \dots$), equations $g_{(\alpha)}$ of formula (2) have the property of invariant length $\overline{W}$:

$$\overline{W} = \sqrt{g^2(\alpha) + g^2(\alpha + \pi/2)} \quad \overline{W} = A \sqrt{2p - q - 1} \quad \overline{W} = \overline{P}_i \overline{P}_{i+1}$$

and defined curves R^N with modulus $N = 4$.

Referring to Figure 2, in which $N = 6$, the rotor vertices are points of a rotoid curve R_6 with 3 symmetry axes $\lambda = \pi/3$: in this case, formula (2) is employed to define a curve L^3 , so that L^3 is defined by equation

$$f_{(\alpha)} = A \sqrt{(p-1) + (1-q) \cos^2(n\alpha/2)}$$

Modulus N and constant length $\overline{W}$ are assigned.

Transformation

$$\left[L^3 \right] \rightarrow \left[R^6 \right]$$

takes place by formula (1) and rotoid curve R^6 is defined by equation:

$$g_{(\alpha)} = \bar{W} f_{(\alpha)} / \sqrt{f_{(\alpha)}^2 + f_{(\alpha+\lambda)}^2 - 2f_{(\alpha)}f_{(\alpha+\lambda)} \cos \lambda}$$

Referring to formula (2), when $n/2 = 1$; $N = 4$, $(p-1) - (1-q) = 1$ (i.e., $p = 2$, $q = 0$), equation $g_{(\alpha)}$ defines rotoid curves R^N of the machines shown in Figure 3, in which the four points P_i are vertices of a family of rhombuses P_i with baricentre in pole C. Vertices P_i are on rotoid curve R^4 defined by:

$$\overline{CP}_1 = A \sqrt{1 + \cos^2 \alpha} \quad \overline{P}_1 \overline{P}_{i+1} = A \sqrt{3}$$

In Figure 3, point D is the midpoint of rotor sides $\overline{P}_i \overline{P}_{i+1}$ and radius $\overline{CD} = \bar{W}/2$ defines a circumference centred in pole C. An inextensible connection (bar 7) joins the middle points of rotor sides $\overline{P}_i \overline{P}_{i+1}$ and $\overline{P}_{i+2} \overline{P}_{i+3}$ to transmission shaft 14.

In Figure 1, bar 7 has a centre of rotation coinciding with baricentre 0 of rhombus P_i .

In the case of other hypotheses, point D need not be on a circumference.

In Figure 6, cross-bar 2 slides on cylinders (disks) 4; point D belongs to contact lines between consecutive cylindrical surfaces E of rings 10; cylinders E have circular bases or radius

$$r = \overline{P}_i \overline{P}_{i+1} / 2 = \bar{W} / 2$$

$$i = 1 \text{ to } N$$

By suitable segments on the ends of rotor vertices and using abrasive fluids, the rotor of the cyclic volume machine may be used as a tool to rectify perimetral surface M of inner stator cavity U. Perimetral surface M of stator cavity U may be radiused with stator bases according to a complementary profile to the profile of rotor surface E.

Claims

1. A rotary machine comprising:
 - one stator with one cylindrical cavity U,
 - one transmission shaft with axis of rotation Y_C ,
 - one rotor with axis of rotation Y_O parallel to axis Y_C and with N_r sides which have N_e equal cylindrical surfaces E at their ends; stator cavity U has a perimetral surface M which is the external envelope of N_e cylindrical surfaces E or N_r rotor sides; surfaces E or any rotor side have longitudinal axes Y_i ($i = 1, 2, \dots, N_e$) parallel to axis Y_C and orthogonally intersecting a plane Γ in points P_i, P_{i+1} at an equal distance $\bar{W}$ for any angular position of the rotor; characterized in that:
 - each rotor side is a rotating and/or translating piston with points P_i and P_{i+1} running along a rotoid curve R^N which has the property of invariant length $\bar{W} = \overline{P}_i \overline{P}_{i+1}$, this curve being obtained by transforming a given simple plane and closed curve L by means of the law

$$g_{(\alpha)} = f_{(\alpha)} \cdot \bar{W} / W_{(\alpha)} \quad (1)$$

wherein:

- $g_{(\alpha)}$ is a non-constant function defining curve R^N in polar coordinates;
 - $f_{(\alpha)}$ is a given continuous positive function defining curve L, $0 \leq \alpha \leq 2\pi$,
 - $\bar{W}$ is the length of segment $\overline{P}_i \overline{P}_{i+1}$ of each piston, $i = 1$ to N ,
 - N is an integer to which the modulus of rotoid curve R^N corresponds,
 - $W_{(\alpha)}$ is the length of the side of an equilateral N -polygon $F_1 F_2 \dots F_N$, with points $F_1, F_2, \dots, F_N$ lying on curve L.
2. A machine according to claim 1, characterized in that:
 - assigned curve $L = L^h$ has h symmetry axes;
 - $N = 2h$;

EP 0 187 148 B1

angles $P_1\hat{C}F_2 = P_2\hat{C}F_3 = \dots P_N\hat{C}F_1 = \lambda$ are constant, wherein C is the point in which axis Y_C intersects Γ ;
rotor axis Y_O and transmission shaft axis Y_C coincide with the symmetry axis of stator cavity U.
3. A machine according to claim 2, characterized in that:
N = 4;

$$g(\alpha) = A \cdot \sqrt{(p-1) + (1-q)\cos^2(n\alpha/2)}$$

wherein n represents the number of symmetry axes of curve R^N and A, p, q are constants.

4. A machine according to claim 2, characterized in that:
the rotor comprises 2h rotor vertices P_i , $i = 1$ to 2h;
assigned curve L^h is defined by equation

$$f(\alpha) = A \cdot \sqrt{(p-1) + (1-q)\cos^2(n\alpha/2)}$$

of claim 3 and rotoid curve R^N is defined by equation:

$$g(\alpha) = \bar{W} f(\alpha) / \sqrt{f^2(\alpha) + f^2(\alpha+\lambda) - 2f(\alpha)f(\alpha+\lambda)\cos\lambda}$$

$$(\lambda = \pi/h)$$

5. A machine according to claim 1, characterized in that:
rotor vertices Q_i , $i = 1$ to N, $N = 4$, are on rotoid curve R^N and maintain a constant distance from rotor baricentre O;
angles $Q_i\hat{O}Q_{i+1} = 2\pi/N$ and angles $Q_i\hat{Q}_{i+1}Q_{i+2}$ are constant;
curve R^N is defined by eccentrically rotating radius $\overline{CO}_1$.
rotor axis Y_O is distinct and parallel to axis Y_C .

6. A machine according to one or more of claims 1 to 5, characterized in that:
the rotor is composed of N equal cylinders E;
cylinders E have circular bases of radius $r = \overline{P_iP_{i+1}}/2 = \bar{W}/2$.

7. A machine according to one or more of claims 1 to 6, characterized in that suitable segments on N cylindrical ends of the rotor vertices are used as tools to rectify perimetral surface M of stator cavity U.

Patentansprüche

1. Rotationsmaschine bestehend aus:

einem Stator mit einer zylindrischen Bohrung U,

einer Antriebswelle mit Rotationsachse Y_C ,

einem Rotor mit Rotationsachsen Y_O parallel zur Achse Y_C und mit N_r Seiten, die N_e gleiche zylindrische Flächen E an den Enden aufweisen; die Bohrung des Stators U hat eine Umfangsfläche M, die aus einer externen Hülle aus N_e zylindrischen Flächen E mit N_r Seiten des Rotors besteht: die Flächen E einer jeden Seite des Rotors haben Längsachsen Y_i ($i = 1, 2, \dots N_e$) parallel zur Achse Y_C , die die Ebene in den Punkten P_i, P_{i+1} in den gleichen Abständen $\bar{W}$ in jeder beliebigen Winkelposition des Rotors rechtwinklig schneiden, dadurch gekennzeichnet, dass:

jede Seite des Rotors ein rotierender und/oder übersetzender Kolben mit den Punkten P_i und P_{i+1} auf einer Rotoidkurve R^N ist, die die Eigenschaft der invarianten Länge $\bar{W} = \overline{P_iP_{i+1}}$ besitzt; wobei diese Kurve durch die Transformation einer flachen, einfachen und geschlossenen Kurve L mit Hilfe des Gesetzes

$$g(\alpha) = f(\alpha) \bar{W} / W_{(\alpha)} \quad (1)$$

enthalten ist, in dem:

$g(\alpha)$ ist eine nicht konstante Funktion, die eine Kurve R^N in polaren Koordinaten definiert,

$f(\alpha)$ ist eine gegebene, stetige und positive Funktion, die die Kurve L definiert, mit $0 \leq \alpha \leq 2\pi$,

$\bar{W}$ ist die Länge des Segments $\overline{P_iP_{i+1}}$ eines jeden Kolbens mit $i = 1$ bis N,

N ist eine ganze Zahl, der das Modul N der Kurve R^N entspricht,

$W_{(\alpha)}$ ist die Länge der Seiten eines gleichseitigen N-Polygons $F_1F_2 \dots F_N$ mit den auf der Kurve L liegenden Punkten $F_1, F_2 \dots F_N$.

EP 0 187 148 B1

2. Maschine nach Anspruch 1, dadurch gekennzeichnet, dass:
die gegebene Kurve $L = L^h$ mit h Symmetrieachsen;

$N = 2h$;

die Winkel $P_1\hat{C}F_2 = P_2\hat{C}F_3 = \dots = P_N\hat{C}F_1 = \lambda$ sind konstant, wobei Γ im Punkt C die Achse Y_C schneidet;

die Achse Y_O des Rotors und die Achse Y_C der Antriebswelle sind mit der Symmetrieachse der Statorbohrung U deckungsgleich.

3. Maschine nach Anspruch 2, dadurch gekennzeichnet, dass:

$N = 4$;

$$g(\alpha) = A \sqrt{(p-1) + (1-q) \cos^2(n\alpha/2)}$$

in der N die Anzahl der Symmetrieachsen der Kurve R^N darstellt und A, p, q Konstante sind.

4. Maschine nach Anspruch 2, dadurch gekennzeichnet, dass:

der Rotor umfasst $2h$ Scheitel des Rotors P_i mit $i = 1$ bis $2h$

die gegebene Kurve L^h ist definiert durch die Gleichung

$$f(\alpha) = A \sqrt{(p-1) + (1-q) \cos^2(n\alpha/2)}$$

der Anspruch 3 und die Rotoidkurve R^N ist definiert durch die Gleichung:

$$g(\alpha) = \bar{W} f(\alpha) / \sqrt{f^2(\alpha) + f^2(\alpha+\lambda) - 2f(\alpha)f(\alpha+\lambda)\cos\lambda}$$

$$(\lambda = \pi/h)$$

5. Maschine nach Anspruch 1, dadurch gekennzeichnet, dass:

die Scheitel des Rotors Q_i , $i = 1$ bis N , $N = 4$, liegen auf einer Rotoidkurve R^N und halten einen konstanten Abstand zum Schwerpunkt O des Rotors ein;

die Winkel $Q_i\hat{O}Q_{i+1} = 2/N$ und die Winkel $Q_i\hat{O}_{i+1}Q_{i+2}$ sind konstant;

die Kurve R^N ist durch den Radius $\overline{OQ_1}$, der exzentrisch verläuft definiert,

die Achse Y_O des Rotors ist parallel und nicht deckungsgleich zur Achse Y_C .

6. Maschine nach einem oder mehreren Ansprüchen 1 bis 5, dadurch gekennzeichnet, dass:

der Rotor besteht aus N gleichen Zylindern E ;

die Zylinder E haben eine kreisförmige Grundfläche mit dem Radius $r = \overline{P_iP_{i+1}}/2 = \bar{W}/2$.

7. Maschine nach einem oder mehreren Ansprüchen 1 bis 6, dadurch gekennzeichnet, dass:

die Segmente der N zylindrischen Enden des Scheitels des Rotors werden als Werkzeug genutzt, um die Umfangsfläche M der U-Bohrung des Stators zu schleifen.

Revendications

1. Machine rotative comprenant:

un stator avec la cavité cylindrique U ,

un arbre de transmission avec l'axe de rotation Y_C ,

un rotor de avec l'axe de rotation Y_O parallèle à l'axe Y_C avec N_r côtés qui ont les N_e surfaces cylindriques égaux E à leurs extrémités; la cavité U du stator a une surface périmétrale M qui est l'enveloppe extérieure des N_e surfaces cylindriques E des N_r côtes du rotor; les surfaces E du chaque côté

du rotor ont les axes longitudinaux Y_i ($i = 1, 2, \dots, N_e$) parallèles à l'axe Y_C et croisent orthogonalement un plan Γ dans les points p_i, P_{i+1} à la même distance $\bar{W}$ quelque soit la position angulaire du rotor;

caractérisée en ce que:

chaque côté du rotor est un piston rotatif et/ou translatif avec les points P_i et P_{i+1} qui courent le long d'une courbe rotoïde R^N qui a la propriété de la longueur invariante $\bar{W} = \overline{P_iP_{i+1}}$, cette courbe est obtenue en transformant une courbe donnée L , simple plane et close au moyen de la loi

$$g(\alpha) = f_{(\alpha)} \cdot \bar{W}/W_{(\alpha)} \quad (1)$$

dans laquelle:

$g_{(\alpha)}$ est une fonction not constant qui définit la courbe R^N au moyen des coordonnées polaires,

EP 0 187 148 B1

$f_{(\alpha)}$ est une fonction donnée continue positive qui définit la courbe L $0 \leq \alpha \leq 2$,

$\bar{W}$ est la longueur du segment $\overline{P_i P_{i+1}}$ de chaque piston, $i =$ de 1 à N,

N est un nombre entier correspondant au module de la courbe R^N ,

$W_{(\alpha)}$ est la longueur du côté d'un N-polygone $F_1 F_2 \dots F_N$ équilatéral, avec les points $F_1, F_2 \dots F_N$ gisant dans la courbe L.

2. Machine selon la revendication 1 caractérisée en ce que:

la courbe donnée $L = L^h$ a h axes de symétrie;

$N = 2h$;

les angles $P_1 \hat{C} F_2 = P_2 \hat{C} F_3 = \dots P_N \hat{C} F_1 = \lambda$, parmi lesquels C est le point où l'axe Y_C croise Γ , sont constants;

l'axe Y_O du rotor et l'axe Y_C de l'arbre de transmission sont coïncidents avec l'axe de symétrie de la cavité U du stator.

3. Machine selon la revendication 2, caractérisée en ce que:

$N = 4$;

$$g(\alpha) = A \sqrt{(p-1) + (1-q) \cos^2(n\alpha/2)}$$

dans laquelle n représente le nombre des axes de symétrie de la courbe R^N et A, p, q sont des constantes.

4. Machine selon la revendication 2, caractérisée en ce que:

le rotor comprend 2h vertexes P_i du rotor, $i =$ de 1 à 2h;

la courbe L^h donnée est définie par l'équation:

$$f_{(\alpha)} = A \sqrt{(p-1) + (1-q) \cos^2(n\alpha/2)}$$

de la revendication 3 et la courbe rotoïde R^N est définie par l'équation:

$$g(\alpha) = \bar{W} f_{(\alpha)} / \sqrt{f_{(\alpha)}^2 + f_{(\alpha+\lambda)}^2 - 2f_{(\alpha)} f_{(\alpha+\lambda)} \cos \lambda}$$

$$(\lambda = \pi/h)$$

5. Machine selon la revendication 1, caractérisée en ce que:

les sommets Q_i $i =$ de 1 à N, $N = 4$, du rotor sont sur une courbe rotoïde R^N et se maintiennent à une distance constante du barycentre O du rotor;

les angles $Q_i \hat{O} Q_{i+1} = 2\pi/N$ et les angles $Q_i \hat{O}_{i+1} Q_{i+2}$ sont constants;

la courbe R^N est définie par le rayon $\overline{CO_1}$ qui tourne d'une façon excentrique,

L'axe Y_O du rotor est séparée et parallèle à l'axe Y_C .

6. Machine selon une ou plusieurs revendications de 1 à 5, caractérisée en ce que:

le rotor est composé de N cylindres E égaux,

les cylindres E ont les bases circulaires du rayon $r = \overline{P_i P_{i+1}}/2 = \bar{W}/2$.

7. Machine selon un ou plusieurs des revendications de 1 à 6, caractérisée en ce que les segments sur les N extrémités cylindriques des sommets du rotor sont employés en tant qu'outils pour la rectification de la surface périmétrale M de la cavité U du stator.

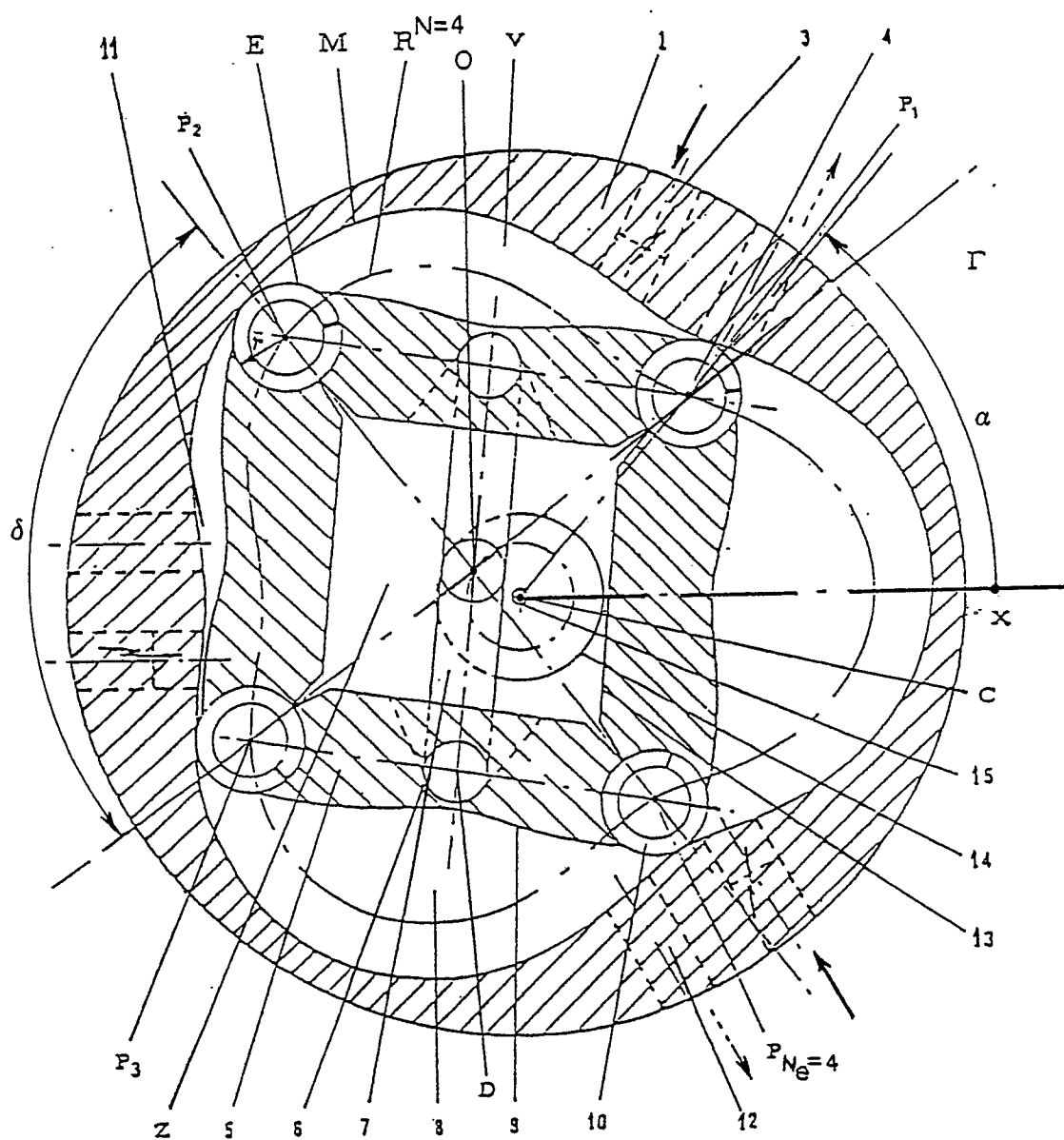


FIGURE 1

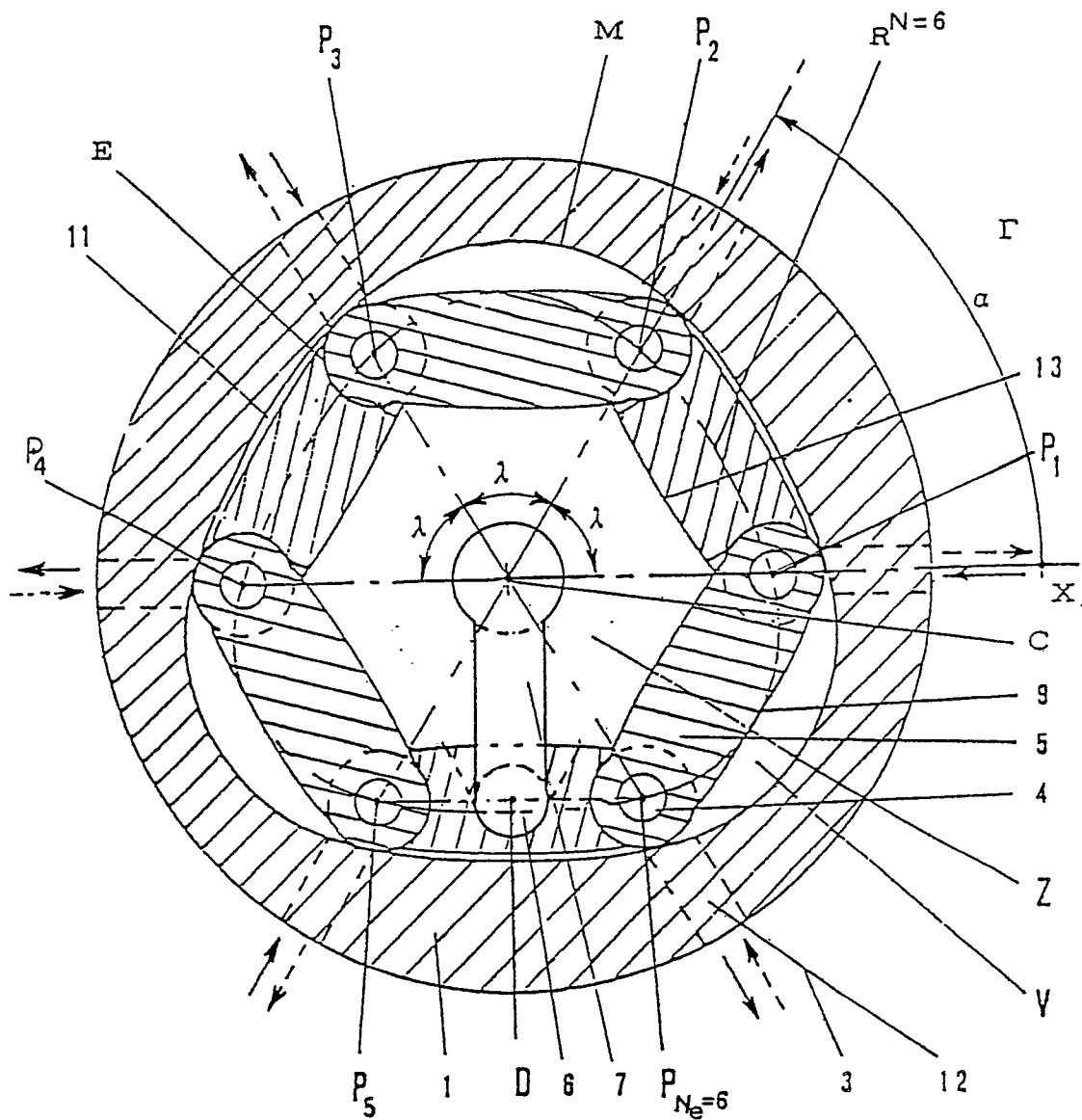


FIGURE 2

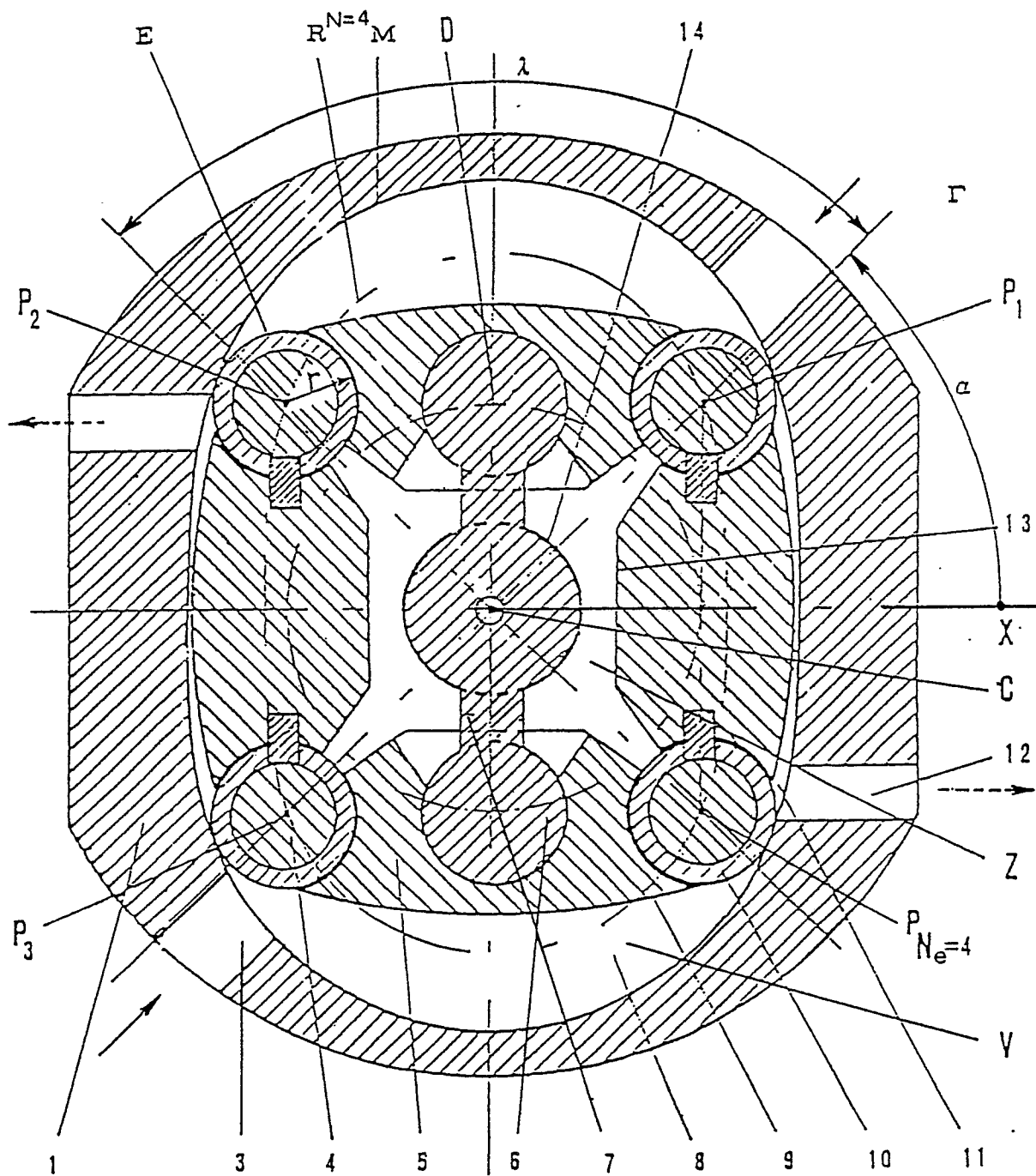


FIGURE 3

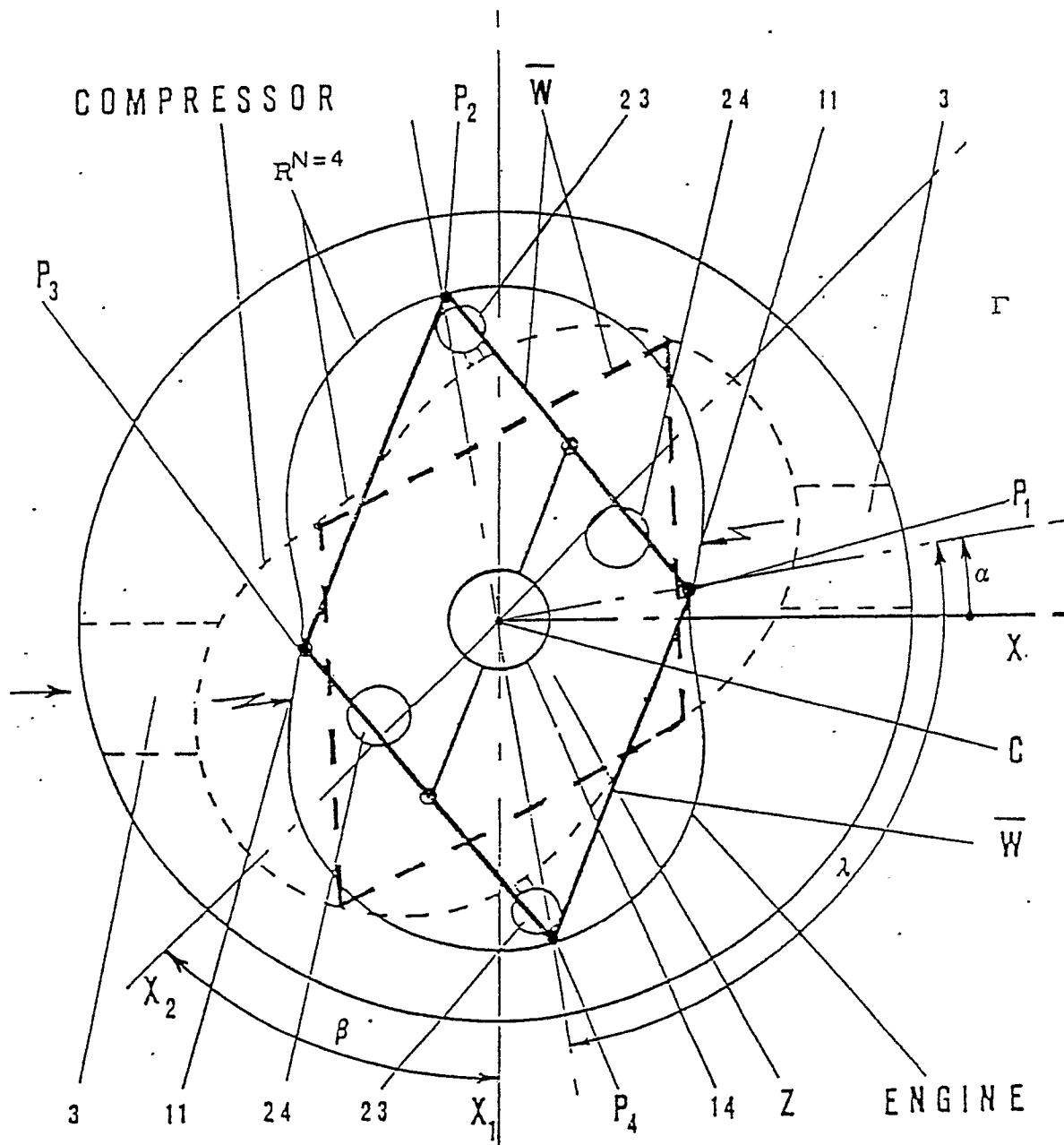


FIGURE 4

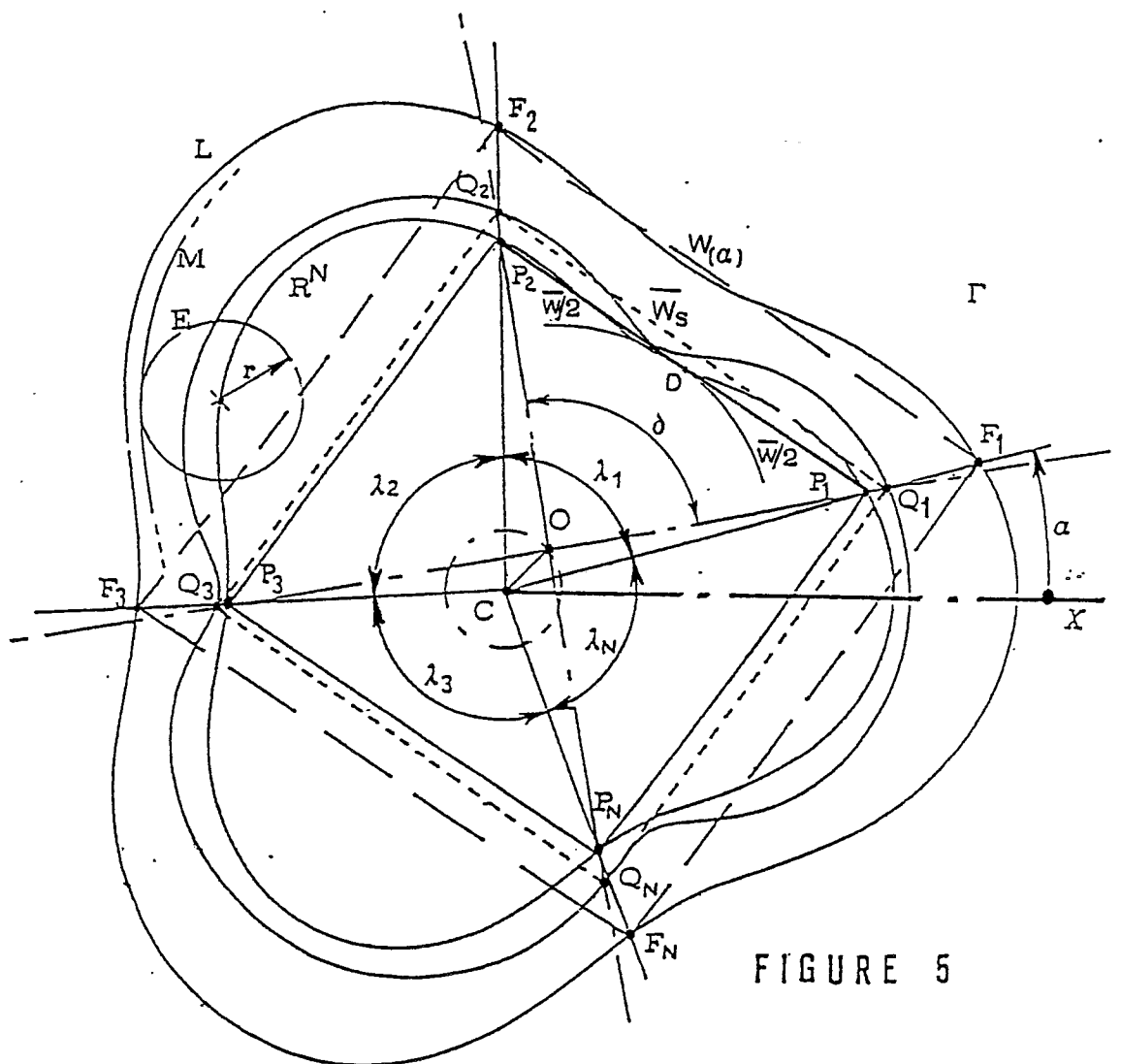


FIGURE 5

