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(54) **Endothermic engine with rotating pistons**

Endothermischer Motor mit drehenden Kolben

Moteur endothermique à pistons rotatifs

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(73) Proprietors:
• **Donato, Giovanni**
27025 Gambolo' PV (IT)
• **Donato, Alessandro**
20100 Milano (IT)

(72) Inventor: **Donato, Giovanni**
27025 Gambolo' PV (IT)

(74) Representative: **Arena, Giovanni**
Viale Certosa 135
20151 Milano (IT)

(56) References cited:
WO-A-01/88341 **WO-A-88/03601**
DE-B- 1 295 569 **FR-A- 1 443 953**
US-A- 2 880 045

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Description

[0001] The present invention relates to an endothermic motor with rotating pistons.

5 BACKGROUND

[0002] Internal combustion motors with pistons are in the great majority of the reciprocating type, i.e. having pistons with alternating movement.

10 **[0003]** As reciprocating piston motors have some drawbacks such as for example their weight, size, construction complexity, the unbalanced arrangement of the masses in movement and relatively limited specific power, there have been experimented with in the past internal combustions motors with rotating pistons of which the one which reached practical realization and is still in use is the motor called Wankel from the name of one of its inventors.

15 **[0004]** The operating principle of this Wankel motor (subject of various patents among which is US 2,988,065) is discussed briefly below with reference to the annexed diagrammatic figures 1A-1D (cross section views) and 1E (exploded view).

20 **[0005]** It includes a stator "a" having an internal chamber "b" of cylindrical shape with trochoidal profile cross section whose surface is concave excepting in two opposed median zones "c" where it is slightly convex. A rotor "f" located within the chamber is connected to a drive shaft "d" (traversing coaxially the chamber) by a cam "e" with circular profile fastened eccentrically to the drive shaft, said rotor consisting of a prismatic body whose cross section has the profile of a triangle with curvilinear sides. During operation of the rotor coupled in a revolving manner to the circular cam, rotation around the axis of the cam causes rotation of said axis around the axis of the drive shaft and consequently rotation of the shaft itself. This takes place with the contribution of two gear wheels "g" and "h" one within the other, of which the first "g" is fixed and coaxial with the drive shaft and the second "h" meshes with the first and is fastened to the rotor.

25 **[0006]** In each of the three hollow spaces delimited by the surface of the stator chamber and by the peripheral surface of the rotor take place strokes of the cyclic operation of the motor similar to those of four-cycle reciprocating endothermic motors.

30 **[0007]** FIGS 1A-1D illustrate how the strokes follow each other in each of the three hollow spaces with each 90° rotation of the drive shaft and with a corresponding 30° rotation of the rotor. Indeed, to the rotor positions illustrated in the FIGS correspond the following strokes in the hollow spaces (f1), (f2) and (f3) adjacent to the sides f1, f2 and f3 of the rotor.

Position of FIG 1A.

35 **[0008]** (f1): end of exhaust stroke through the exhaust duct "l" and beginning of the suction stroke through the suction duct "m"; (f2): beginning of compression stroke; (f3) expansion stroke following mixture ignition by spark plug "i".

Position of FIG 1B.

40 **[0009]** (f1): continuation of suction stroke; (f2): compression stroke; (f3) maximum of expansion stroke and beginning of exhaust.

Position of FIG 1C.

45 **[0010]** (f1): continuation of suction stroke; (f2): ignition and maximum compression stroke; (f3): continuation of exhaust stroke.

Position of FIG 1D.

50 **[0011]** (f1): end of suction stroke; (f2): expansion stroke following ignition of mixture; (f3) continuation of exhaust stroke.

[0012] From the above description it appears that in the Wankel motor there are three useful cycles (one for each hollow space) with each revolution of the rotor to which correspond three revolutions of the drive shaft and therefore there is a useful cycle with each revolution of the shaft.

55 **[0013]** Document DE-B-12955569 discloses an endothermic engine with rotating pistons with an inner chamber, a drive shaft and rods with one end connected rigidly to the drive shaft and the other end hinged with a respective piston of prismatic shape, the pistons having a convex surface with two rectilinear apical edges. The section profile of the inner chamber is ovoidal and is constructed adopting for two opposite parts a circumference arch and for the remaining parts curves obtained point by point by the trajectory traced by one apical edge of a piston when the other edge moves along one of the two circumference arches.

OBJECTS OF THE INVENTION

[0014] The purpose of the present invention is realization of an endothermic motor with rotating pistons which compared with prior art motors and in particular with the Wankel motor would display at least one of the following advantages:

- greater construction simplicity,
- a higher number of useful cycles for each revolution of the drive shaft,
- greater specific power, and
- more balanced arrangement of the moving masses.

SUMMARY OF THE INVENTION

[0015] According to the inventive solution of broadest scope the endothermic motor with rotating pistons envisages a cycle of operation comprising the strokes of suction, compression, expansion and fluid exhaust and the presence of:

- a stator having an internal stator chamber with cylindrical form closed at its ends by two base plates and provided with a fluid exhaust duct from the chamber and a fluid suction duct into the chamber,
- a drive shaft traversing said chamber coaxially, and
- a rotor connected to the drive shaft and having during its rotation surfaces facing on parts of the surface of the stator chamber and delimiting with said parts work chambers of volume variable with the rotation of the drive shaft,

wherein:

- the rotor comprises rods functioning as cranks, each with one end connected rigidly to the drive shaft and with the other end hinged to a respective prismatically shaped piston;
- said piston has one convex face surface ending on two opposite sides with two apical rectilinear edges parallel to the axis of the drive shaft, said face during rotation of the drive shaft always facing parts of the surface of the stator chamber and displaying a curvature never greater than the curvature of said parts, and in that
- the stator chamber displays a cross section with ovoidal profile symmetrical with two axes perpendicular to each other and shaped to ensure for each position of the rotor a sealed contact with said apical edges.
- calling "l" and "L" the lengths of the shorter and respectively the longer semiaxes of the ovoidal profile of the stator chamber and calling "r" the value $0.5 \cdot \sqrt{L^2 + l^2}$, the apical edges of each piston display a distance from each other of 2·r.

The motor is characterized by the fact that:

- the axis of the hinge of each piston is located on the plane defined by the two apical edges and equidistant therefrom,
- the distance of the axis of the hinge from the axis of the drive shaft is
- the profile of the stator chamber is expressed in polar coordinates by the equation:

$$\rho(\theta) = 2r \cdot \cos((\Psi_M - \Psi_m) \cdot \sin^2\theta + \Psi_m)$$

where $\Psi_M = \arccos(l/2r)$ and $\Psi_m = \arccos(L/2r)$.

[0016] Preferred embodiments are set forth in the claims below.

DRAWINGS

[0017] To better clarify the purposes and characteristics of the present invention exemplifying preferred embodiments thereof are described below and illustrated in the annexed drawings (Figs. 2-13) wherein:

FIG.2: shows a diagrammatic perspective view of an assembled motor in accordance with the present invention,

FIG.3: shows an exploded view of the motor of FIG 2,

FIGS. 4A-4D: show diagrammatic cross section views of the same motor with different rotation angles of

the drive shaft,
 FIG.5: shows a diagrammatic view of the stator chamber and the rotor illustrating a preferred sizing criterion of the rotor and chamber,
 FIGS. 6A-6D: show axonometric views of the body 1c of FIG 3,
 5 FIGS. 7A-7B: show axonometric views of the plate 1a of FIG 3,
 FIGS. 8A-8E: show axonometric views of a piston of FIG 3,
 FIGS. 9A-9B: show axonometric views of the cranks 3a and 3a' of FIG 3,
 FIGS. 10A-10B: show axonometric views of a piston pin acting as a hinge,
 FIGS. 11, 12, 13A-13B show the equivalent to FIGS 3, 4, 9A and 9B in case the motor is realized with three rotating
 10 pistons.

PREFERRED EMBODIMENTS OF THE INVENTION

[0018] FIGS 2, 3 and 4A-4D illustrate the solution idea on which the present invention is based.

[0019] In fact the endothermic motor in accordance with the present invention calls for an operational cycle comprising suction, compression, expansion and fluid exhaust strokes and the presence of:

- a stator 1 comprising a cylindrical body 1c with a cylindrical internal stator chamber closed at its ends by two base plates 1a -1b and provided with a duct 1d for fluid exhaust from the chamber and a duct 1e for fluid suction into the chamber,
- a drive shaft 2 traversing said chamber coaxially, and
- a rotor 3 connected to the drive shaft and during its rotation having surfaces facing on parts of the surface of the stator chamber and delimiting with said parts work chambers whose volume varies with rotation of the drive shaft.

[0020] The motor displays the following characteristics:

- the rotor 3 comprises two rods 3a, 3a' functioning as cranks and each with one end connected rigidly to the drive shaft and the other end hinged with a respective prismatically shaped piston 3b, 3b',
- the above mentioned piston 3b, 3b' has a face 3b₁, 3b'₁ with convex surface and ending on two opposite sides with two apical rectilinear edges 3b[^], 3b'[^] parallel to the axis of the drive shaft,
- during rotation of the drive shaft the above mentioned face is always facing parts of the surface of the stator chamber and displays a curvature never greater than the curvature of said parts (cf. FIGS 4A-4D),
- the stator chamber displays a cross section with ovoidal profile symmetrical with two axes (x,y) perpendicular to each other and shaped in such a manner as to ensure for each rotor position a sealed contact with both of said apical edges 3b[^] (3b'[^]).

[0021] FIG 5 shows a diagrammatic view of the stator chamber and the rotor illustrating a preferred sizing criterion for the same.

[0022] In accordance with this criterion, having called "L" and "l" the lengths of the two semiaxes of the ovoidal cross section profile of the stator chamber and having called "r" the value $0.5 \cdot \sqrt{L^2 + l^2}$, each piston 3b, 3b' is sized in such a manner that the distance between its apical edges is equal to 2r while the axis of the hinge connecting the crank 3a, 3a' to the respective piston 3b, 3b' is located in the plane defined by said apical edges and equidistant therefrom while the crank 3a, 3a' is sized in such a manner that the distance between the axis of the above mentioned hinge and the axis of the drive shaft is equal to "r". Adopting these preferred sizing criteria the curve representing the stator chamber profile is expressed in polar coordinates by the following equation:

$$\rho(\theta) = 2r \cdot \cos((\Psi_M - \Psi_m) \cdot \sin^2\theta + \Psi_m)$$

where:

$$\Psi_M = \arccos(l/2r)$$

$$\Psi_m = \arccos(L/2r)$$

[0023] Indeed, with these sizing criteria the angle in the center subtended by the chord PP' (FIG 5) is always straight and the coordinates p and p' of any two points of the curve spaced angularly by 90° always satisfy the relationship $\rho^2(\theta) + \rho'^2(\theta + \pi/2) = (2r)^2$ and this ensures that for each position of the rotor the apical margins are always in contact with the stator surface.

[0024] In accordance with a preferred choice the relationship L/l is assumed within a range of between 1.15 and 1.35.

[0025] Assuming in particular L/l = 1.28 and sizing l = 7.8 cm it results L = 10 cm, r = 6.34115 cm and $\rho(\theta) = 12.6823 \cdot \cos(0.246 \cdot \sin^2 \theta + 0.6624)$ cm.

[0026] In each of the two hollow spaces delimited by the stator chamber surface and by the peripheral surfaces of the rotor pistons there take place cyclic operational strokes of the motor similar to those of four-stroke reciprocating endo-thermic motors (since the motor can adopt either the Diesel or the Otto system for ignition, the hole 1f in FIGS 3 and 4A indicates the seat of the injection device or respectively of the spark plug).

[0027] FIGS 4A-4D illustrate how the strokes in each one of the two hollow spaces follow each other with each 45° rotation of the rotor and the drive shaft.

[0028] Indeed, the following strokes in the hollow spaces (3b) and (3b') adjacent to the peripheral surfaces of the pistons 3b and 3b' correspond to the rotor positions illustrated in the FIGS.

Position of FIG 4A.

[0029] (3b): end of exhaust stroke through the exhaust duct "1d" and beginning of the suction stroke through the suction duct "1e", (3b'): ignition and maximum compression stroke.

Position of FIG 4B.

[0030] (3b): continuation of suction stroke; (3b'): continuation of expansion stroke.

Position of FIG 4C.

[0031] (3b): maximum suction stroke; (3b'): maximum expansion stroke.

Position of FIG 4D.

[0032] (3b): compression stroke; (3b'): exhaust stroke.

[0033] The above description shows that there are two useful cycles in the motor (one for each hollow space) for each revolution of the rotor and crank shaft.

[0034] FIGS 6A-6D show diagrammatically axonometric views of the cylindrical body 1c in FIGS 2 and 3 and more precisely the front view (FIG 6A), top view (FIG 6B), bottom view (FIG 6C) and side view (FIG 6D).

[0035] FIGS 7A and 7B show respectively the front and side views of the plate 1a shown in FIGS 2 and 3.

[0036] FIGS 8A-8E show axonometric views of a piston of FIG 3 and more precisely the top view (FIG 8A), front view (FIG 8B), exploded bottom view (FIG 8C), exploded cross section view (FIG 8D) and side view (FIG 8E) of the piston without the apical insert referred to below.

[0037] In the FIGS the parts marked have the following meanings:

- 81: space for housing the upper end of the crank and a piston pin 10 (FIG 10A, 10B) acting as a hinge,
- 82: holes within which are housed the ends of the piston pin and roller bearings holding the piston pin (not shown in the FIGS),
- 83: curved groove on the sides of the piston acting as a seat for an curved metallic segment 88 (FIG 8B) stressed by springs (not shown in the FIGS) to emerge from said seat in order to press against the internal wall of the plates 1a and 1b to ensure side seal,
- 84: cross section view of a component with prismatic shape realizing the apical ends of the piston,
- 85: housing of the basic body of the apical end 84 designed to be fitted in a running manner in cavities of the piston in which there are springs (not shown in the FIGS) stressing said basic body to emerge from said cavity in order to press against the cylindrical wall of the stator chamber to ensure apical seal,
- 86: side view of the head of the apical end 84 showing peripheral ribbing with notch designed to allow entry of one end of the curved segment fitted in the groove 83, and

87: seat of spring (not shown in the FIGS) stressing said end of the curved segment fitted in the groove 83 to press against the inner wall of the plates 1a and 1b to ensure side seal.

[0038] FIGS 9A and 9B show (in reduced scale compared to that used for FIGS 8) respectively the top and front views of the cranks 3a, 3a' and the drive shaft 2 while FIGS 10A and 10B show respectively the top and side views of the piston pin to be fitted with the ends in the holes 82 of each piston (FIGS 8A-8C).

[0039] FIG 9B shows that the crank ends 3a and 3a' are shaped like a fork and that the piston pin 10 in its median part displays a square cross section. Indeed, this part is designed to be fastened by keying in the cavity of said fork as shown in broken lines in FIG 9B.

[0040] Naturally numerous modifications, adaptations, variants, omissions and replacements of members by others functionally equivalent can be made to the above described embodiments without abandoning the scope of the invention.

[0041] One of such variants could concern for example the number of pistons. Indeed, FIGS 11, 12, 13A and 13B show the equivalent of FIGS 3, 4, 9A and 9B if the motor is realized with three rotating pistons. In this case the sizing criteria and in particular the form of the stator cavity and that of the pistons are similar to the above while the number of useful cycles per revolution of the drive shaft will go from two to three.

[0042] From the above description the advantages of the present invention as compared with the prior art are evident and in particular with respect to the Wankel motor. Indeed:

- there is greater construction simplicity deriving from the absence of couplings with eccentric cams and couplings of geared wheels,
- the useful cycles for each motor revolution are doubled (two-piston solution) or tripled (three-piston solution) with resulting increase in specific power of the motor, and
- moving eccentric masses are eliminated.

Claims

1. Endothermic motor with rotating pistons (3b, 3b') whose operational cycle includes suction, compression, expansion and fluid exhaust strokes and in which there are:

- a stator (1) having an internal stator chamber with cylindrical shape closed at its ends by two base plates (1a, 1b) and provided with an exhaust duct (1d) for exhaust of fluid from the chamber and a suction duct (1e) for fluid suction into the chamber,
- a drive shaft (2) traversing said chamber coaxially,
- a rotor (3) connected to the drive shaft and having during its rotation surfaces facing on parts of the surface of the stator chamber and delimiting with said parts work chambers of volume variable with the rotation of the drive shaft,

wherein:

- the rotor comprises rods (3a, 3a') functioning as cranks with each having one end connected rigidly to the drive shaft (2) and the other end hinged with a respective piston (3b, 3b') of prismatic shape,
- said piston has a convex surface face (3b₋, 3b'₋) terminating on two opposite sides with two rectilinear apical edges (3b[^], 3b'[^]) parallel with the axis of the drive shaft,
- said face (3b₋, 3b'₋) during rotation of the drive shaft always faces on parts of the surface of the stator chamber and displays a curvature never greater than the curvature of said parts, and
- the stator chamber displays a cross section with ovoidal profile symmetrical with two mutually perpendicular axes (x, y) and shaped in such a manner as to ensure with each rotor position sealed contact with both of said apical edges, thereby defining a hollow space delimited by the stator chamber surface and the convex surface face of the piston and in which the operational cycle takes place,
- calling "l" and "L" the lengths of the shorter and respectively the longer semiaxes of the ovoidal profile of the stator chamber and calling "r" the value $0.5 \cdot \sqrt{L^2 + l^2}$ the apical edges (3b[^], 3b'[^]) of each piston display a distance from each other of 2·r,

characterized by the fact that:

- the axis of the hinge of each piston is located on the plane defined by the two apical edges and equidistant

therefrom,

- the distance of the axis of the hinge from the axis of the drive shaft is "r",
- the profile of the stator chamber is expressed in polar coordinates by the equation:

$$\rho(\theta) = 2r \cdot \cos((\Psi_M - \Psi_m) \cdot \sin^2\theta + \Psi_m)$$

where $\Psi_M = \arccos(l/2r)$ and $\Psi_m = \arccos(L/2r)$.

2. Endothermic motor in accordance with claim 1 **characterized in that** the L/l ratio is between 1.15 and 1.35.
3. Endothermic motor in accordance with claim 2 in which the L/l ratio is 1.28.
4. Endothermic motor in accordance with claim 1 in which the rods functioning as cranks are two located in a diametrically opposite position.
5. Endothermic motor in accordance with claim 1 in which the rods functioning as cranks are three and angularly equidistant from each other.
6. Endothermic motor in accordance with one of the above claims **characterized in that** the ends of each piston delimited by said apical edges are realized in the form of components (84) movable in a direction parallel to the plane defined by the two apical edges and perpendicular to said edges, and stressed by springs towards the surface of the stator chamber to ensure seal of the piston on its apical edges.

Patentansprüche

1. Endothermer Motor mit rotierenden Kolben (3b, 3b'), dessen Betriebszyklus Ansaug-, Kompressions-, Arbeits- und Fluid-Auslasshub aufweist und in welchem vorhanden sind:

- ein Stator (1), der eine innere Statorkammer mit zylindrischer Form aufweist, die an ihren Enden durch zwei Grundplatten (1a, 1b) verschlossen ist und mit einem Auslasskanal (1d) zum Auslassen von Fluid aus der Kammer und einem Ansaugkanal (1e) zum Ansaugen von Fluid in die Kammer versehen ist,
- eine Antriebswelle (2), welche die Kammer coaxial durchquert,
- ein Rotor (3), der mit der Antriebswelle verbunden ist und während seiner Rotation Flächen aufweist, die Teilen der Oberfläche der Statorkammer zugewandt sind und mit den Teilen Arbeitskammern begrenzen, deren Volumen mit der Rotation der Antriebswelle variabel ist,

wobei:

- der Rotor Stangen (3a, 3a') umfasst, die als Kurbelarme fungieren, wobei von jeder ein Ende starr mit der Antriebswelle (2) verbunden ist und das andere Ende mit einem jeweiligen Kolben (3b, 3b') von prismatischer Form gelenkig verbunden ist,
- der Kolben eine konvexe Oberflächenseite (3b₋, 3b'₋) aufweist, die auf zwei einander gegenüberliegenden Seiten mit zwei geradlinigen, an der Spitze befindlichen Kanten (3b[^], 3b'[^]) endet, die zur Achse der Antriebswelle parallel sind,
- die Seite (3b₋, 3b'₋) während der Rotation der Antriebswelle immer Teilen der Oberfläche der Statorkammer zugewandt ist und eine Krümmung aufweist, die niemals größer als die Krümmung der Teile ist, und
- die Statorkammer einen Querschnitt mit ovalem Profil aufweist, das symmetrisch bezüglich zweier zueinander senkrechter Achsen (x, y) ist und auf eine solche Weise geformt ist, dass bei jeder Rotorposition ein dichter Kontakt mit den beiden an der Spitze befindlichen Kanten sichergestellt ist, wodurch ein Hohlraum definiert ist, der von der Oberfläche der Ständerkammer und der konvexen Oberflächenseite des Kolbens begrenzt wird und in welchem der Betriebszyklus stattfindet,
- wenn man mit "l" und "L" die Längen der kürzeren bzw. der längeren Halbachse des ovalen Profils der Statorkammer bezeichnet und mit "r" den Wert $0,5 \cdot \sqrt{L^2 + l^2}$ bezeichnet, die an der Spitze befindlichen Kanten (3b[^], 3b'[^]) jedes Kolbens einen Abstand von 2·r voneinander aufweisen,

dadurch gekennzeichnet, dass:

- sich die Achse des Gelenks jedes Kolbens in der Ebene befindet, die durch die zwei an der Spitze befindlichen Kanten definiert ist und von ihnen äquidistant ist,
- der Abstand der Achse des Gelenks von der Achse der Antriebswelle "r" beträgt,
- das Profil der Statorkammer in Polarkoordinaten durch die Gleichung

$$\rho(\theta) = 2r \cdot \cos((\psi_M - \psi_m) \cdot \sin^2 \theta + \psi_m)$$

ausgedrückt wird, wobei $\psi_M = \arccos(l/2r)$ und $\psi_m = \arccos(L/2r)$.

2. Endothermer Motor nach Anspruch 1, **dadurch gekennzeichnet, dass** das Verhältnis L/l zwischen 1,15 und 1,35 beträgt.
3. Endothermer Motor nach Anspruch 2, bei welchem das Verhältnis L/l gleich 1,28 ist.
4. Endothermer Motor nach Anspruch 1, bei welchem die Anzahl der als Kurbelarme fungierenden Stangen zwei beträgt und diese sich in diametral gegenüberliegenden Positionen befinden.
5. Endothermer Motor nach Anspruch 1, bei welchem die Anzahl der als Kurbelarme fungierenden Stangen drei beträgt und diese in gleichen Winkelabständen voneinander angeordnet sind.
6. Endothermer Motor nach einem der obigen Ansprüche, **dadurch gekennzeichnet, dass** die Enden jedes Kolbens, die von den an der Spitze befindlichen Kanten begrenzt werden, in der Form von Komponenten (84) ausgeführt sind, die in einer Richtung beweglich sind, die zu der durch die zwei an der Spitze befindlichen Kanten definierten Ebene parallel und zu den Kanten senkrecht ist, und von Federn zu der Oberfläche der Statorkammer hin belastet werden, um die Abdichtung des Kolbens an seinen an der Spitze befindlichen Kanten sicherzustellen.

Revendications

1. Moteur endothermique à pistons tournants (3b, 3b') dont le cycle de fonctionnement comprend des courses d'aspiration, de compression, d'expansion et d'échappement du fluide, et comprennent :

un stator (1) comportant une chambre interne de stator de forme cylindrique fermée à ses extrémités par deux plaques de base (1a, 1b), et muni d'un conduit d'échappement (1d) pour l'échappement du fluide de la chambre et d'un conduit d'aspiration (1e) pour l'aspiration du fluide dans la chambre ;

un arbre d'entraînement (2) traversant coaxialement la chambre ;

un rotor (3) connecté à l'arbre d'entraînement et ayant pendant sa rotation des surfaces tournées vers des parties de la surface de la chambre de stator et délimitant avec lesdites parties des chambres de travail de volume variable avec la rotation de l'arbre d'entraînement ;

dans lequel :

le rotor comprend des tiges (3a, 3a') fonctionnant comme bielles, ayant chacune une extrémité reliée rigidement à l'arbre d'entraînement (2) et l'autre extrémité articulée avec un piston respectif (3b, 3b') de forme prismatique ; le piston a une face convexe (3b₋, 3b'₋) se terminant sur deux bords opposés par deux bords extrêmes rectilignes (3b[^], 3b'[^]) parallèles à l'axe de l'arbre d'entraînement ;

la face (3b₋, 3b'₋), pendant la rotation de l'arbre d'entraînement, faisant toujours face à des parties de la surface de la chambre de stator et présentant une courbure qui n'est jamais supérieure à la courbure desdites parties ; et la chambre de stator présente une section de profil ovoïde symétrique avec deux axes mutuellement perpendiculaires (x, y) et conformée de façon à assurer pour chaque position du rotor un contact étanche avec les deux bords extrêmes, définissant ainsi un espace creux délimité par la surface de chambre de stator et la face convexe du piston, et dans lequel le cycle de fonctionnement prend place ;

en appelant "l" et "L" les longueurs des demi-axes respectivement le plus court et le plus long du profil ovoïde de la chambre de stator et en appelant "r" la valeur $0,5 \cdot \sqrt{L^2 + l^2}$, les bords extrêmes (3b[^], 3b'[^]) de chaque piston

présentent une distance l'un par rapport à l'autre de $2 \cdot r$;

caractérisé en ce que :

- 5 l'axe d'articulation de chaque piston est disposé dans le plan défini par les deux bords extrêmes et équidistant de ceux-ci ;
la distance de l'axe de l'articulation à l'axe de l'arbre d'entraînement est " r " ;
le profil de la chambre de stator s'exprime en coordonnées polaires par l'équation :

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$$\rho(\theta) = 2r \cdot \cos[(\Psi_M - \Psi_m) \cdot \sin^2 \theta + \Psi_m]$$

où $\Psi_M = \arccos(l/2r)$ et $\Psi_m = \arccos(L/2r)$.

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2. Moteur endothermique selon la revendication 1, **caractérisé en ce que** le rapport L/l est compris entre 1,15 et 1,35.

3. Moteur endothermique selon la revendication 2, dans lequel le rapport L/l est de 1,28.

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4. Moteur endothermique selon la revendication 1, dans lequel les tiges agissant comme bielles sont au nombre de deux et sont disposées à des positions diamétralement opposées.

5. Moteur endothermique selon la revendication 1, dans lequel les tiges fonctionnant comme manivelles sont au nombre de trois et sont angulairement équidistantes.

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6. Moteur endothermique selon l'une quelconque des revendications précédentes, **caractérisé en ce que** les extrémités de chaque piston délimitées par les bords extrêmes sont réalisées sous forme de composants (84) mobiles dans une direction parallèle au plan défini par les deux bords extrêmes et perpendiculairement auxdits bords, et sollicités par des ressorts vers la surface de la chambre de stator pour assurer l'étanchéité du piston, au niveau de ses bords extrêmes.

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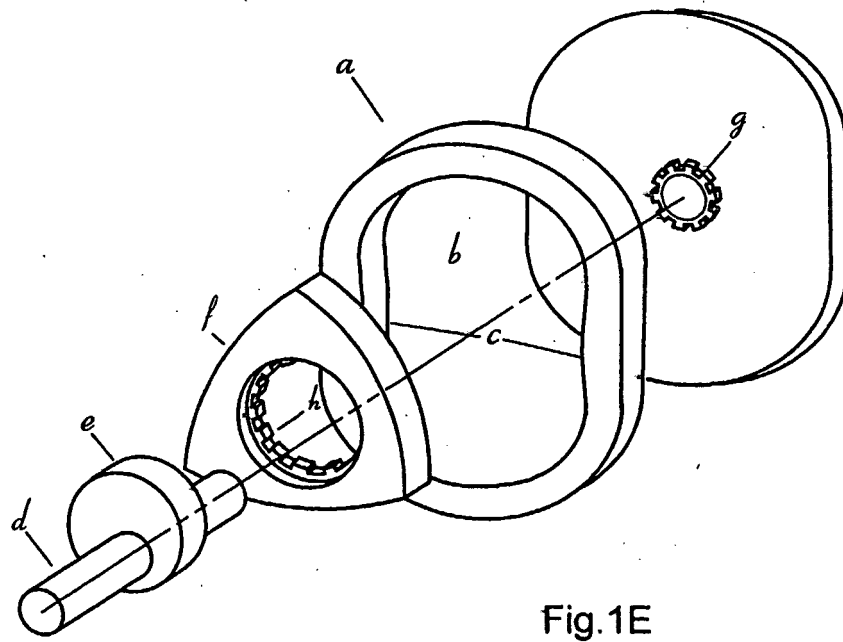
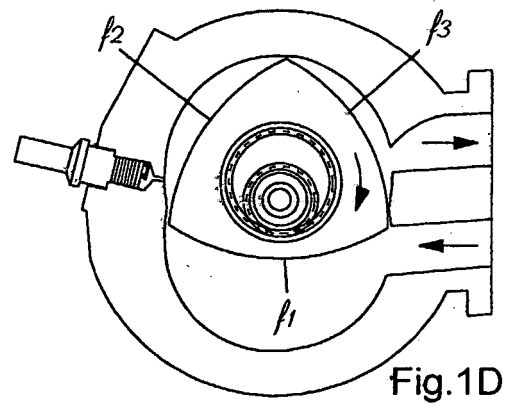
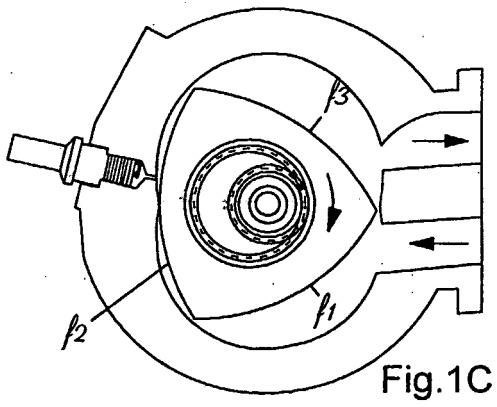
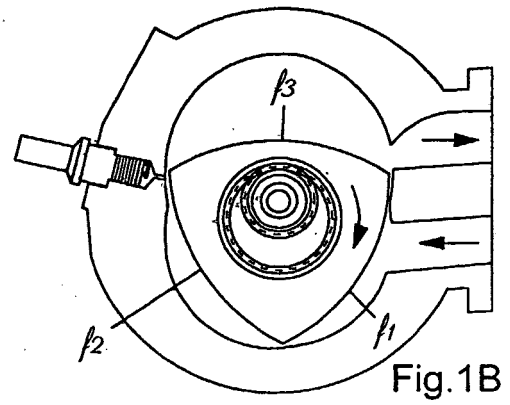
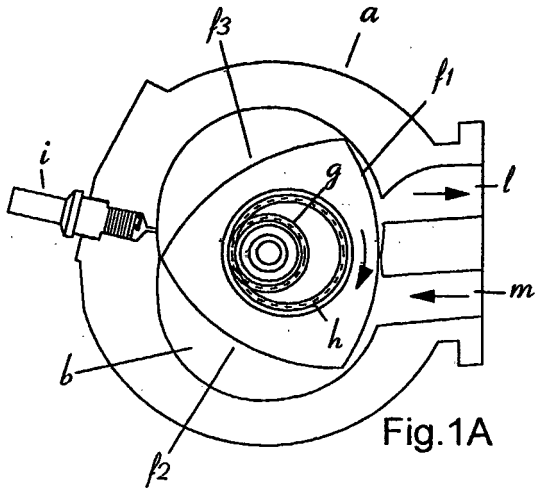
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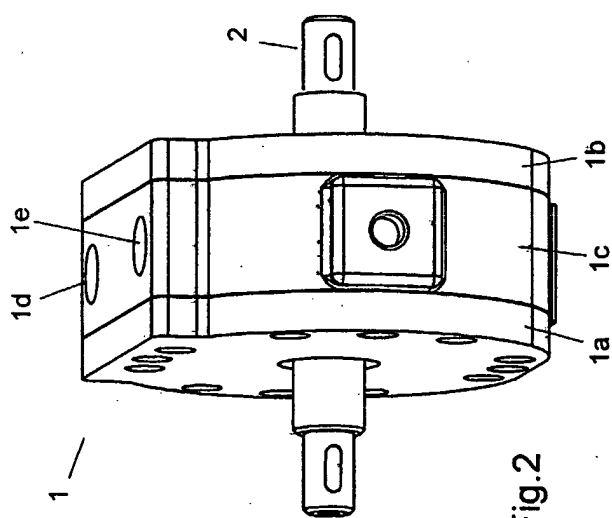


Fig. 2

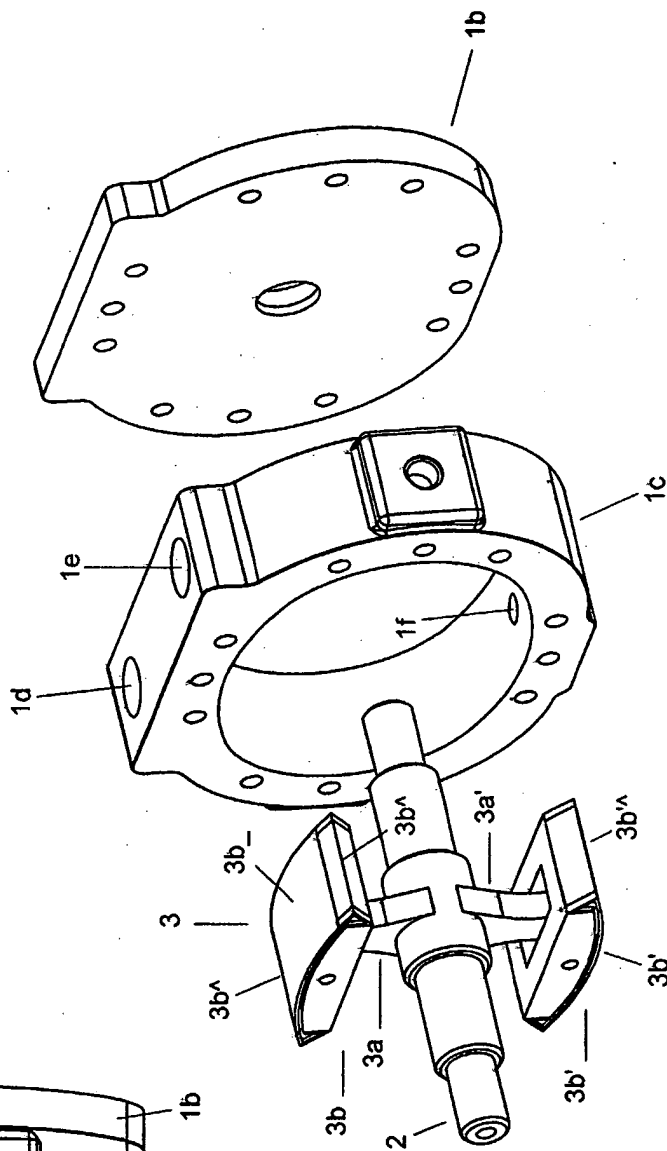


Fig. 3

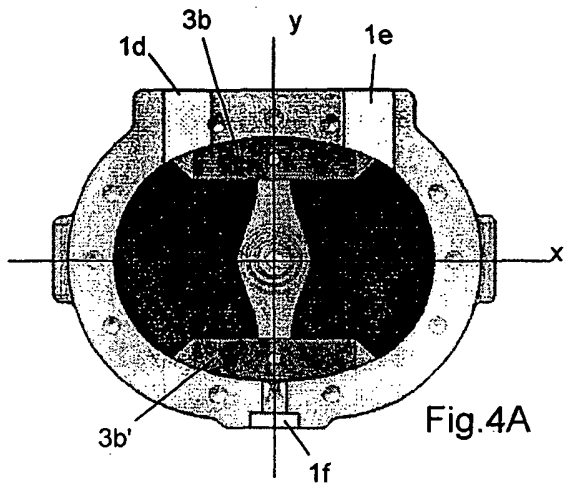


Fig. 4A

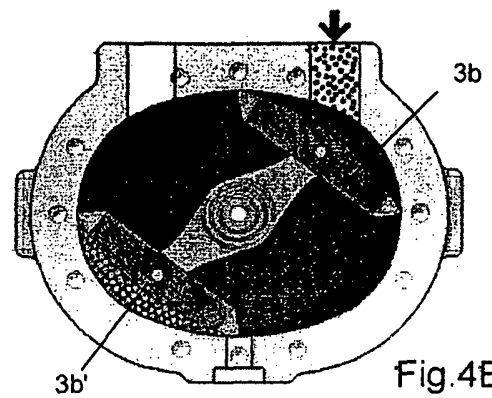


Fig. 4B

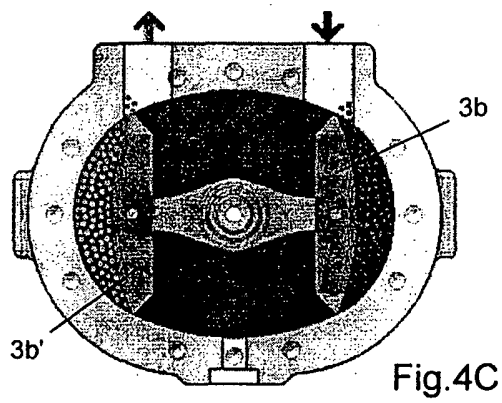


Fig. 4C

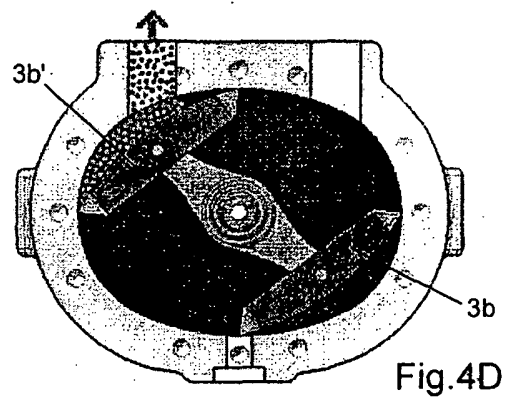


Fig. 4D

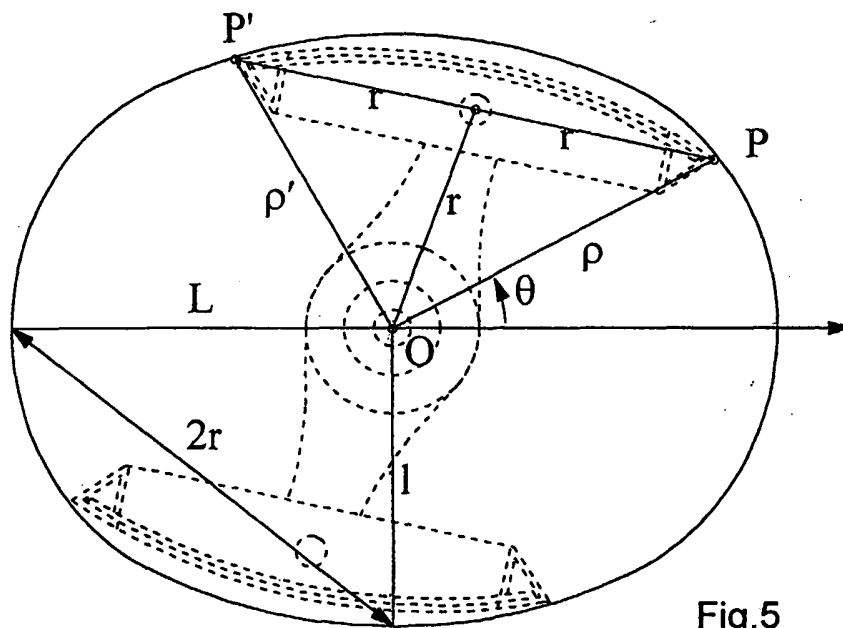
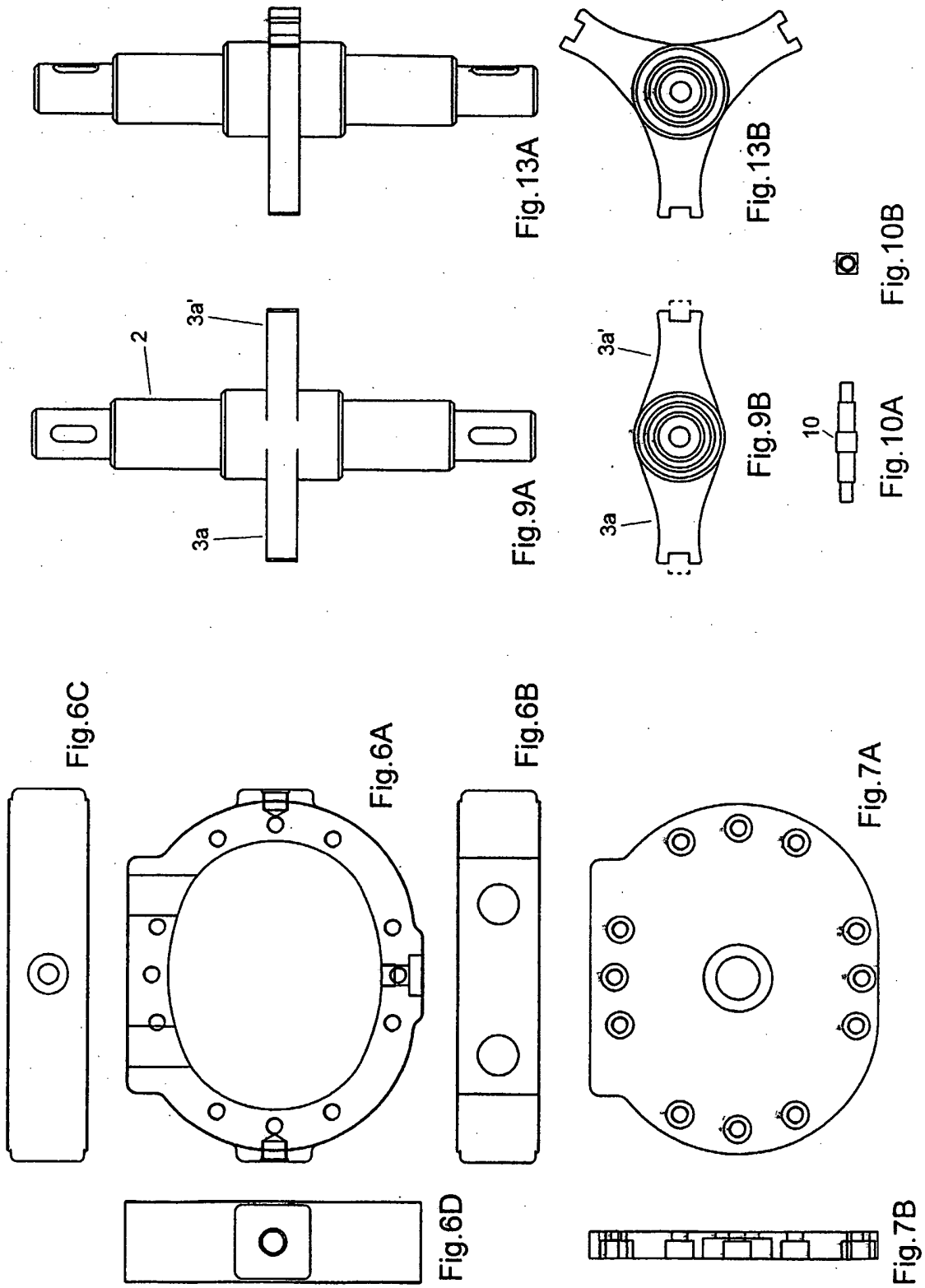


Fig. 5



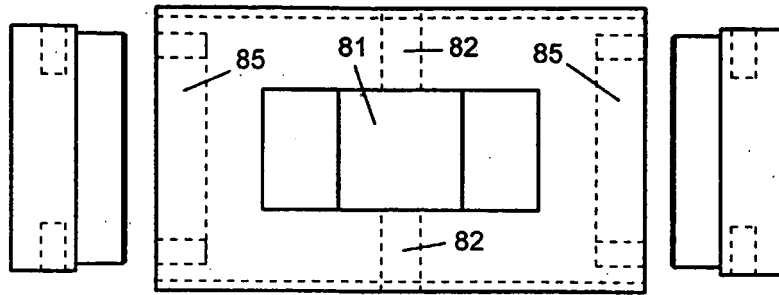


Fig. 8C

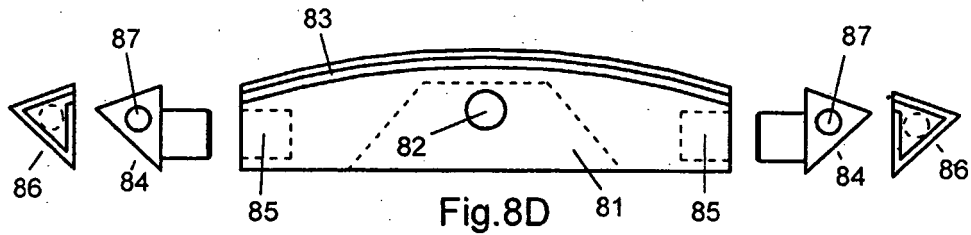


Fig. 8D

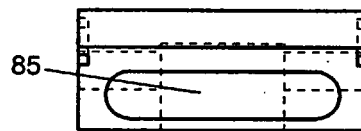


Fig. 8E

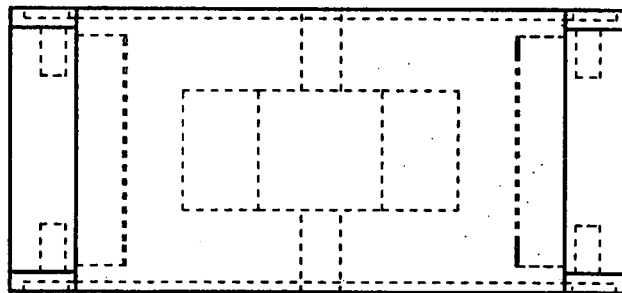


Fig. 8A

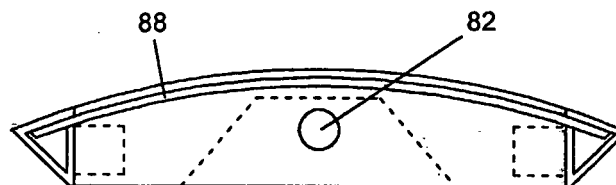


Fig. 8B

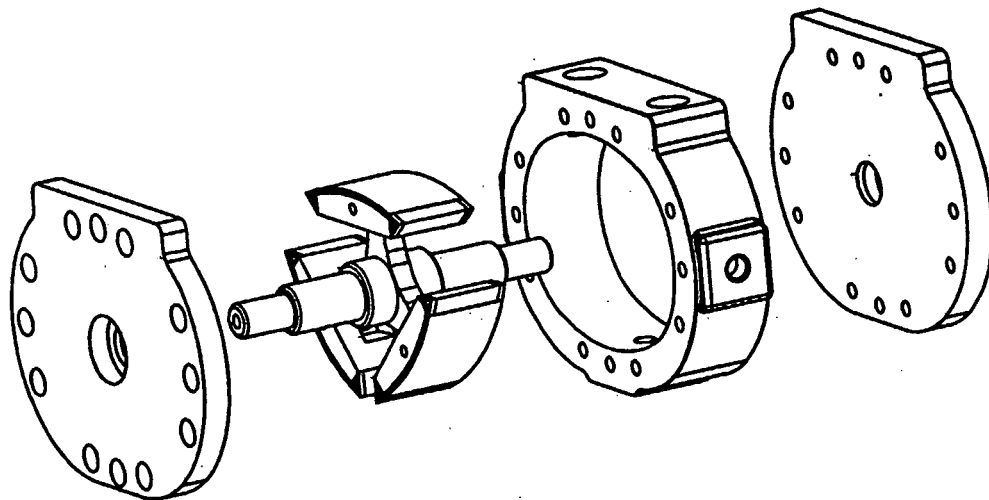


Fig.11

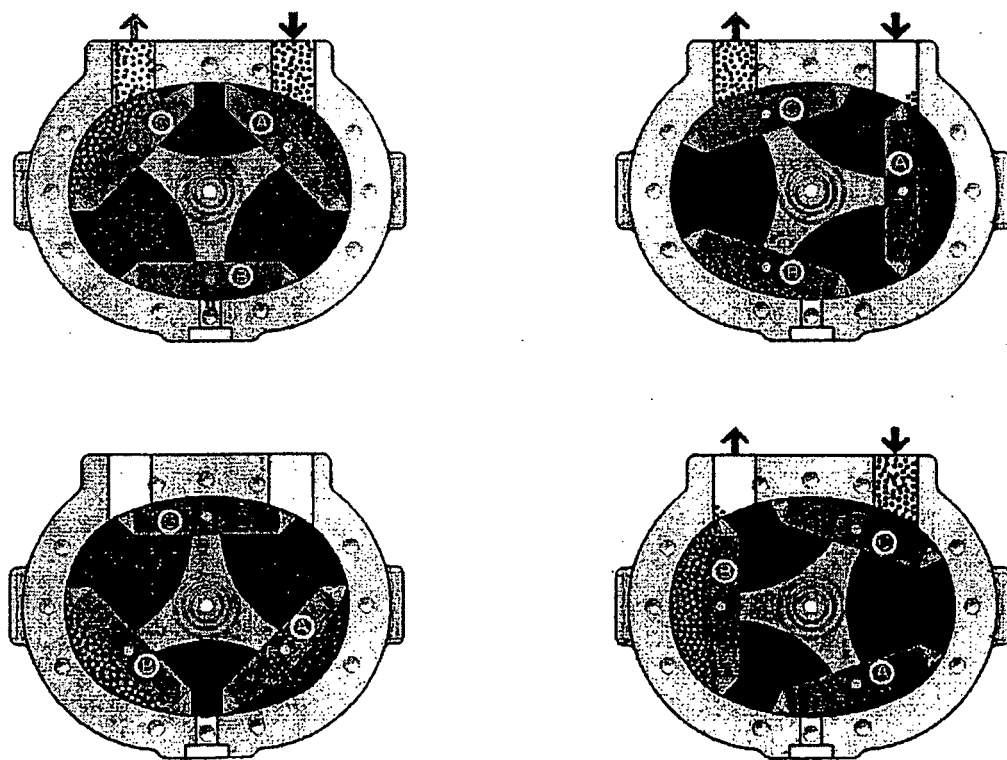


Fig.12