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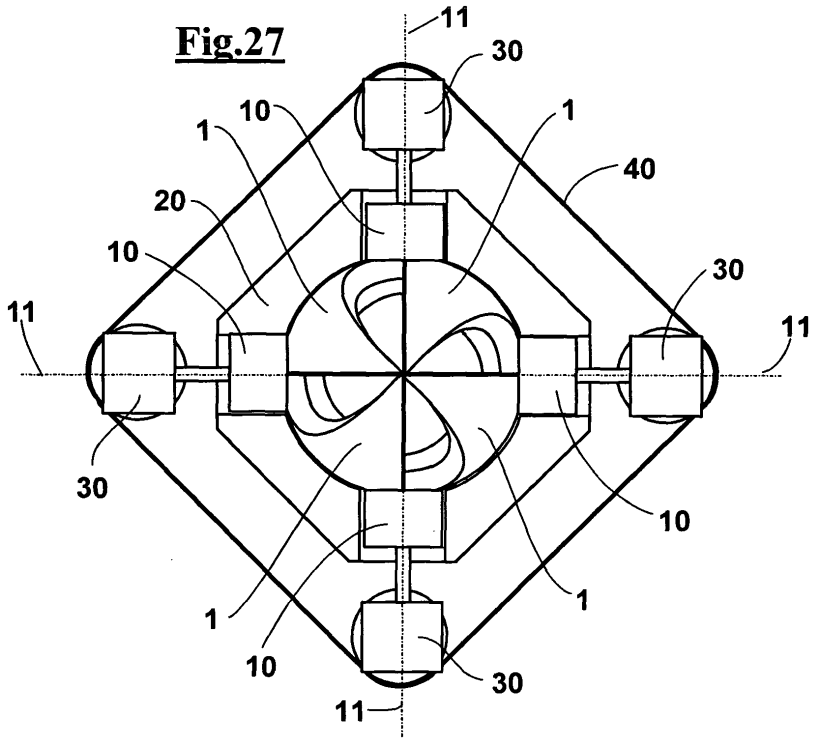
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(54) Rotary pistons machine

(57) A volumetric rotary machine for generating or transforming mechanical energy comprising four rotary bodies rotating about a respective rotation axes, said four rotary bodies having said respective axes two by two perpendicular and two by two coincident but opposite to each other, wherein each rotary body has a recess that is penetrated by the two adjacent rotary bodies with axis perpendicular to each other, the rotary bodies with axis perpendicular to each other being mirror-like and counter-rotating, the rotary bodies with axes coincident and opposite being alike and counter-rotating, said recess penetrated by said rotary bodies creating at least four variable volume chambers, the volume of said chambers being responsive to the angular relative position between said rotary bodies, said chambers shrinking and expanding alternatively ; at least one fluid inlet and a fluid outlet present in at least one said inlet and outlet resulting in at least one position in said chambers; a stiff containing structure arranged about said four rotary bodies, adapted to support said rotary bodies allowing their relative movement.

Fig.27



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Description

Field of the invention

[0001] The present invention relates to the mechanical field of machines adapted for transforming or obtaining mechanical energy.

Background of the invention.

[0002] The need is felt to provide a volumetric rotary machine for generating or transforming mechanical energy, which is configurable as internal combustion engine or as actuating operating machine, having a configuration adapted to exploit the energy of an expanding gas better than the presently existing machines, obtaining a lower pressure and temperature of the exhaust gas higher efficiency.

[0003] Furthermore, many known internal combustion engines have relatively sliding parts, which, owing to the high working temperature, are subject to mechanical wear and risk of seizure requiring to dissipate much heat to limit the maximum temperature. Therefore the need is felt to provide an internal combustion machine without sliding surfaces.

Summary of the invention

[0004] It is then a feature of the present invention to provide a volumetric rotary machine that solves these problems and meets said needs.

[0005] A particular feature of the present invention is to provide an operating machine rotative volumetric that is configurable both as machine combustion inner that as volumetric operating rotary machine as pump or as compressor.

[0006] Another object is to provide a rotary machine that, without any mechanical parts having sliding surfaces in contact with one another, allows heat resistance quality higher than in known machines.

[0007] A further feature of the invention is to provide a machine with high efficiency and compression ratio.

[0008] It is still a feature of the invention to provide an internal combustion machine capable of working with a very high temperature drop between hot source and cold source and a very high pressure drop.

[0009] Another object is to provide an internal combustion machine capable of fully evacuating the burnt gas from the combustion chamber before the suction of a fresh fuel charge.

[0010] A further feature of the invention is to provide a machine without reciprocating masses, so that it has an agile operation and substantially without vibrations, that is substantially noiseless.

[0011] It is still a feature of the invention to provide a machine with compact external shape.

[0012] These and other objects are achieved by a volumetric rotary machine for generating or transforming mechanical energy, characterised in that it comprises:

- four rotary bodies rotating about a respective rotation axes, said four rotary bodies having said respective axes two by two perpendicular and two by two coincident but opposite to each other, wherein each rotary body has a recess that is penetrated by the two adjacent rotary bodies with axis perpendicular to each other, the rotary bodies with axis perpendicular to each other being mirror-like and counter-rotating, the rotary bodies with axes coincident and opposite being alike and counter-rotating, said recess penetrated by said rotary bodies creating at least four variable volume chambers, the volume of said chambers being responsive to the angular relative position between said rotary bodies, said chambers shrinking and expanding alternatively;
- at least one fluid inlet and a fluid outlet present in at least one said inlet and outlet resulting in at least one position in said chambers;
- a stiff containing structure arranged about said four rotary bodies, adapted to support said rotary bodies allowing their relative movement.

[0013] Advantageously, said containing structure has inner spheric shape.

[0014] In particular, each rotary body of said four rotary bodies has said rotation axes, a plane face orthogonal to said rotation axis and having a spiral-shaped opening, a spherical portion defined by on said plane face and by a couple of curved end portions separated by said rotation axes, an inner recess that originates from said spiral-shaped opening and plunges into said rotary body following a spiral shape, said spiral-shaped recess having transversal sections and axial sections consisting of portions of spiral and being defined by walls having thickness substantially the same as the pitch of said spiral.

[0015] Advantageously, said spiral shapeis obtained according to a spiral of Archimede.

[0016] In particular, said curved end portions are symmetrical in a plane passing through said rotation axis and perpendicular to said plane face, said curved end portions being defined by points rotationally equidistant both from on said plane face and from a plane passing through said rotation axis.

[0017] In particular, between said rotary bodies and between said rotary bodies and said stiff structure a gap is provided adapted to allow the relative rotation of the rotary bodies without contacting each other and to to limit fluid leakage between said chambers.

[0018] Preferably, said gap has a thickness less than 1mm.

[0019] In particular, each rotary body comprises a shaft portion opposite to said spiral-shaped opening and having an axis coincident with said rotation axes. This way, the machine has four shafts in pairs perpendicular to each other and belonging to a plane, each shaft being pivotally connected to said support structure. This way, taking two

of said rotary bodies that are opposite to each other, they have respective plane faces opposite to each other at a minimum distance from each other and not penetreting each other. The same occurs for the other two opposite rotary bodies and with axes orthogonal to the former two rotary bodies. Instead, each rotary body penetrates the other adjacent rotary bodies that are opposite to each other, since its "positive" portion occupies instantly a part of the two "negative" portions of the two adjacent rotary bodies, i.e. the spiral-shaped recess, taking into account of the different directions of rotation and the mirror-like shape of two adjacent rotary bodies.

[0020] Advantageously, said machine comprises motion transmitting means arranged between each shaft and an output shaft capable of providing mechanical power.

[0021] In particular, said motion transmitting means comprise a bevel gear integral to each shaft adapted to mesh with a corresponding gear integral to an adjacent shaft.

[0022] Advantageously, said variable volume of said four chambers changes cyclically in an increasing way starting from a first minimum value up to a maximum value and then in a decreasing way up to a second minimum value.

[0023] In a particular exemplary embodiment, said volumetric rotary machine is an internal combustion machine and said inlet comprises at least one inlet duct, made in a respective rotary body, adapted to bring in said chambers a fresh fuel charge, whereas said outlet comprises at least one outlet duct adapted to expel the burnt gas.

[0024] Advantageously, said outlet is arranged according to a respective position fixed on said stiff containing structure. This way, said opening is alternatively closed and opened automatically by the movement of the outer back surface of said rotary body.

[0025] Advantageously each rotary body of said internal combustion engine comprises a central portion, integral to a central part of said rotary body, having a plane face that is an extension of on said plane face of said rotary body, and a couple of concave curved surfaces that join to on said plane face according to a first edge, said curved surfaces crossing along a second rectilinear edge incident to said first edge and passing through the rotation axis of said rotary body. The extension of said recess of each rotary body and, therefore, the length angular of a cycle with the machine depending from the angular position of said first edge.

[0026] In a particular exemplary embodiment, said at least one inlet duct passes through each rotary body and is adapted to connect the outer environment with at least two of said chambers in a predetermined zone of said chambers. In particular, said at least one inlet duct comprises a fuel injector adapted to inject the fuel along the flow of said fresh fuel charge.

[0027] In particular, said predetermined zone is located on one of said concave curved surfaces of said central portion, in particular the mostly inner surface.

[0028] Advantageously, said central portion comprises a device for igniting said fresh fuel charge, in particular, a sparkling plug, arranged according to a position selected from the group comprised of:

- on said plane face of said central portion;
- one of said concave curved surfaces of said central portion.

[0029] In a preferred exemplary embodiment, said outlet from said two first chambers is connected to a respective inlet of two second chambers by at least one return duct. This way in said first two chambers the suction and the compression of a fresh fuel charge is carried out, whereas in said second two chambers out the combustion and the expulsion of the burnt gas is carried, said fresh fuel charge passing in a compressed condition from said first two chambers to said second two chambers. Furthermore, this way two suction and compression steps occur at the same time of two combustion and exhaust steps.

[0030] Preferably, said return duct is obtained in at least two of said rotary bodies, said duct having a first end on one of said curved end portions and a second end on said central portion.

[0031] In a possible exemplary embodiment, said return duct comprises at least one valve adapted to obstruct in a synchronized way said return duct during the expansion owing to the combustion.

[0032] In particular, each of said four return ducts comprises a fuel injector and at least one valve adapted to obstruct said four ducts in a synchronized way during the expansion owing to the combustion.

[0033] According to an alternative exemplary embodiment, each outlet from said four chambers is connected to an inlet of four chambers through a transfer duct.

[0034] In particular, said transfer duct comprises at least one first valve adapted to block said duct during the combustion and to open said duct during the compression for conveying the fresh compressed fuel charge from the periphery of each chamber to the central portion.

[0035] In particular, said inlet duct has a first end oriented out of the machine and at least one second end at said central portion, said at least one second end comprising a second valve adapted to be opened during the suction step and closed during the combustion step.

[0036] In particular, said inlet duct has a third end that connects said chamber in a zone of maximum volume, preferably said end comprising a third valve.

[0037] In a particular exemplary embodiment, said transfer duct and said inlet duct coincide, said inlet duct comprising a fourth valve arranged upstream from said second and third valve adapted to block said inlet duct during the transfer through said transfer duct between said second and third end.

[0038] In a possible exemplary embodiment, said first and/or second and/or third valve are nonreturn valves,

whereas said fourth valve is a controlled valve.

[0039] This way four chambers carry out a suction and a compression of a fresh fuel charge, this fresh fuel charge, when compressed, is transferred into four successive chambers where the expansion occurs owing to the combustion and the expulsion of the burnt gas.

[0040] Alternatively, said volumetric rotary machine is a compressor for a fluid or a pump for liquid.

[0041] Advantageously, said compressor for a fluid or said pump for liquid has a central spherical recess defined by spherical surface portions belonging to each rotary body, said central recess communicating with said chambers for predetermined rotation angle of said rotary bodies.

[0042] Advantageously, said fluid inlet in said chambers comprises at least one suction duct in at least one rotary body adapted to connect said central spherical recess with a fluid ready for suction, said duct having a first end connected to said spherical surface portion by a first opening. This way the expansion step of the chambers produce a depression in the chambers that causes the suction of the fluid same.

[0043] Advantageously, in case of a pump for liquid, said at least one suction duct comprises at least one second opening communicating with said central recess.

[0044] In a further exemplary embodiment, said internal combustion machine is associated to said compressor, said operating machine being connected to said compressor by at least four connection ducts adapted to connect said compressor outlet means with said inlet ducts of said operating machine.

[0045] According to another exemplary embodiment, said compressor is obtained about said operating machine, said operating machine being arranged according in said spherical recess of said compressor, each rotary body of said operating machine being co-axial and integral to a corresponding rotary body of said compressor. This way the inlet of fresh fuel charge is obtained without the use of auxiliary compressors.

Brief description of the drawings

[0046] The invention will be made clearer with the description of some exemplary embodiments, exemplifying but not limitative, with reference to the attached drawings wherein:

- Figures from 1 to 4 show four different views of an example of a rotary body of a machine according to the invention in case of internal combustion machine;
- Figure 5 shows a cross sectional view of such a rotary body, with a plane passing through its rotation axis;
- Figures from 6 to 8 show a perspective view of three respectively different shapes of such a rotary body, corresponding to three different ratios between maximum volume and minimum volume of the chambers due to three different shapes of a central portion;
- Figures 9 and 10 show two perspective views of this central portion;
- Figure 11 shows four rotary bodies both in separated and assembled position in operation in order to rotate on four perpendicular axes;
- Figures 12-16 show such a rotary body divided into two assemblable parts for allowing to assemble the machine according to the invention;
- Figure 17 shows a succession of relative positions of four central portions belonging to respective rotary bodies during a complete cycle, showing the evolution of the creation of four equal chambers;
- Figure 18 shows a succession of relative positions of four rotary bodies, showing the evolution of the peripheral part of four groups of equal chambers;
- Figure 19 shows a rotary body of an internal combustion machine obtained according to the invention, having a inlet port for the mixture and a point of ignition;
- Figure 19A shows an opposite view of the rotary body of figure 19, wherein an opening the inlet duct is arranged on a curved end portion of the rotary body;
- Figure 20 shows a rotary body as a pump for liquid obtained according to the invention;
- Figure 21 shows a duct of a rotary body of such a machine;
- Figure 22 shows a rotary body as a volumetric compressor obtained according to the invention;
- Figure 23 shows diagrammatically the course of the volume of a chamber responsive to the angle of rotation, of a machine according to the invention;
- Figure 24 shows diagrammatically the course of the volume of two chambers successive;
- Figure 25 shows the course of the volume on a cycle with a machine according to the invention comprising a first step of suction and compression and a second step of expansion and expulsion;
- Figure 26 shows a diagrammatical view of the operation of an exemplary embodiment of an internal combustion machine according to the invention;
- Figure 27 shows a cross sectional view of a possible configuration of a machine according to the invention, where the motion of the four shafts is transmitted to one another by means of corresponding four reductors and a transmission belt;
- Figure 28 shows a cross section of another exemplary embodiment of a machine according to the invention where the rotation between the four axes is transmitted by means of corresponding beveled gears integrated to the machine with a spherical outer compressor obtained according to the invention; this example comprises an operating machine according to the invention in the central part and a compressor according to the invention in the peripheral part;
- Figure 29 shows an exploded view of an example of internal combustion machine according to the invention, having a compressor according to the invention

in the peripheral part;

- Figure 30 shows a cross sectional partial view of such a machine once assembled, without the rotary bodies;
- Figure 31 shows a perspective three-dimensional view an outer compressor obtained according to the invention,
- Figure 32 shows the evolution of variable volume chambers that are formed between the rotary bodies and a compressor obtained according to the invention in a peripheral zone of an operating machine obtained according to the invention.

Description of the preferred exemplary embodiment

[0047] In the following description an example of volumetric rotary machine, according to the invention, for generating or transforming mechanical energy by the simultaneous rotation of four rotary bodies 1A, 1B, 1C, 1D shown in figure 11, having each a rotation axis 11A, 11B, 11C and 11D, such rotary bodies being arranged so that such rotational axes are incident and perpendicular belonging to a same plane, between such rotary bodies at least one group of four equal chambers being created, not shown in the figure, whose volume changes cyclically between a minimum value and a maximum value during the rotation of the rotary bodies. As shown in figure 11, the front face 5A of rotary body 1A is facing the front face 5C of rotary body 1C, 1A and 1C creating a couple of rotary bodies counter rotating about coincident axes 11A and 11C. Similarly, front face 5B of rotary body 1B faces the front face 5D of rotary body 1D, 1B and 1D, creating a couple of rotary bodies counter rotating about coincident axes 11B and 11D. Rotary bodies 1A and 1C have mirror-like shape with respect to rotary bodies 1B and 1D. In other words, each rotary body rotates in a direction contrary to the direction of rotation of the other two rotary bodies adjacent and perpendicular. When assembled together the above described four rotary bodies form an assembly 12 with substantially spherical external shape and having four perpendicular shafts continuously rotating about axes 11A, 11B, 11C and 11D, each shaft being integral to the respective rotary body. Between the four rotary bodies no sliding occurs since minimum a gap is present, having thickness preferably less than 1mm. The net drawn on the elements of figure 11 is not a real feature of the rotary bodies but is used only for highlighting its the curved shape.

[0048] Figures 1 and 4 show two opposite side views of an example of rotary body 1, as shown in figure 11, whereas figure 2 shows a top plan view and figure 3 a view from below thereof, with respect to rotation axis 11. Each rotary body 1, as shown also in the examples of figures 5-8, has a plane face 5 orthogonal to the rotation axis 11, a spiral-shaped opening, in particular, an Archimedean spiral, on the front face 5, having origin on axis 11, an inner recess 4 having a spiral-shaped cross section, in particular, an Archimedean spiral. Rotary body 1 has a spiral-shaped external surface 3 and inner surface 6 that define a wall. As shown in figure 5, this rotary body 1, when cross-sectioned with a plane passing through the rotation axis 11, provides sections 7 with spiral-shaped edge, also in this case Archimedean spirals, obtained as intersection of surfaces 3 and 6. Rotary body 1 comprises a spherical portion 2 with axis coincident to axis 11, which covers substantially a half of the rotary body same, having an end on plane face 5 and an end comprising two curved end portions 14 and 14' symmetrical with respect to a midplane passing through axis 11 and perpendicular to plane face 5. Each of such curved end portions 14 is defined by a curved surface consisting of points rotationally equidistant both from the plane of front face 5 and from the plane passing through axis 11 and perpendicular to the above described plane of symmetry. This shape of the curved end portions 14 is adapted to allow the relative rotation of the four rotary bodies. Furthermore, the spherical shape of portion 2 is adapted to allow the rotation of the rotary bodies in a spherical containing structure 20 shown in figures 27, 28 and 29.

[0049] In a particular exemplary embodiment, as shown in figures 12-16, the above described rotary bodies 1 can be obtained in two assemblable parts 170 and 171, allowing to assemble the four rotary bodies in order permit their mutual rotation about the respective rotational axes. Rotary body 1, shown in assembled configuration in figure 16, is shown in a cut configuration in two separate parts 170 and 171 in figures 12 and 13, whereas in figures 14 and 15 the above described separate parts 170 and 171 are shown comprising inlet ducts 19 and connection means between the parts same, which in the embodiment described are two screws 172 passing through two corresponding holes 173 obtained in the part 171 and screwed into corresponding screw threaded holes made in part 170. Inlet ducts 19, have been shown in figures 14 and 15 for simplicity, but actually would not be visible being within the rotary body same. Along the surfaces of separation between parts 171 and 170, ducts 19 come to an end, and on such ducts can be present.

[0050] Figure 17 shows a succession of positions, corresponding to angular successive positions, of four central portions of respective four rotary bodies, illustrating the creation and the development, near to the central portions, of a group of four equal chambers, that, in any case are not at the same time shown in the figure. Such positions are spaced by 30° degrees of rotation each. At the position 0° two chambers 200 and 201 are shown whereas other two equal chambers are created at the opposite region and then not shown in the figure. After a rotation of 30° of the rotary bodies a chamber 203 is created whereas the chambers 200 and 201 change their own shape. At each instant at least one group of four equal chambers is always present, and then also in this configuration, in addition to chambers 203 other four equal chambers are created and not shown in the figure. By the rotation chamber 203 increases its volume, whereas chamber 200 decreases. After a further rotation, at

180°, a configuration is shown where only two chambers are shown 203 and 204. Then other four chambers are formed of which only chamber 205 is visible in the figure, whereas the chambers of which chamber 204 is visible, after a first portion where they increase the volume have a decrease up to annulling it at 360°. The angular course shown is purely descriptive and the correspondence between angles of rotation and configurations of the chambers depends on the geometry of the rotary bodies.

[0051] Similarly, figure 18 shows a succession of configurations, corresponding to following angular positions of the four rotary bodies, which shows the evolution of the geometry of the peripheral zone of a group of four chambers, responsive to the angular position. At a position of 0° the peripheral zone of two chambers 300 and 301 is shown of a group of four chambers. Progressively wit the rotation the creation of an opening at the boundary of a chamber 302 and its variation during the rotation of the rotary bodies is shown. At 330° the creation is shown of an opening 304 and then an opening 307. The course of the creation of the apertures of the chambers responsive to the angle of rotation depends on the shape of the rotary bodies, which in the case described is that of figure 7.

[0052] A machine obtained according to the invention comprises the four rotary bodies having a geometry described in the previous figures, that can be formed in order to work as volumetric operating machine capable of transforming mechanical energy into pressure, such as a volumetric compressor or a pump, or as internal combustion machine capable of transforming thermal energy, developed in a combustion step in a central zone, into mechanical energy supplied to a rotating shaft.

[0053] In case of an operating machine or internal combustion engine, the above described group of four equal chambers that is formed between the four rotary bodies 1 comprises chambers that arise from a central portion 8, which, as shown in figures from 6 to 10, belongs to rotary body 1 and can be conformed in many ways for not allowing a free rotation of adjacent rotary bodies 1. In particular, the shape of this central portion 8, described in figures 9 and 10, comprises a first rectilinear edge 15 given by the intersection between a plane passing through the front face 5 and two curved concave surfaces 9 and 9' that join on a second rectilinear edge 15' perpendicular to the first edge and arranged along the rotation axis 11. Figure 6 shows a rotary body 1 having a central portion 8 with first edge 15 arranged according to an angle predetermined with respect to the geometry of the rotary body same. In figure 7 a rotary body 1 is shown having the first edge 15 rotated of 90° with respect to that of figure 6 and, in figure 8 a rotary body is shown with edge rotated of 180° always with respect to that of figure 6. Obviously, this edge 15 can be arranged according to an desired angle different from those mentioned. Advantageously in the description of an exemplary embodiment of the invention the geometry of the example of figure 7 will be referred to. During the operation as operating machine, i.e. during the relative rotation of the four rotary bodies, the above described four chambers is formed starting from a central zone at the above described central portion 8 and starting from volume zero. Progressively with the rotation of rotary bodies 1, the volume of the chambers increases according to an increasing portion 102 shown diagrammatically in figure 23, having in abscissas 100 the angular position of the rotary body and in ordinates 101 the volume, achieving a maximum 104 at an angle predetermined and then decreasing, portion 103, up to zeroing at another predetermined angle on the boundary of the machine. The values of such angles depend on the geometry of the rotary body and, in particular, assume the values described in the drawing in case of referencwe to the example of figure 7.

[0054] In a first possible shape of a internal combustion engine, a gaseous mixture of fuel and comburent in pressure, is injected at the same time in each four chambers at the central portion 8, for a time corresponding to a predetermined rotation, which for the particular geometry of figure 7, goes substantially from 0° to 90°. About at this position of rotary bodyre a sparkling is created at the same time in each four chambers for igniting the mixture and creating an expansion of the gas that on in figure 23 is shown by the increasing portion 102. In this portion the machine produces work. Then, the rotation of the rotary bodies reduces the volume of the chambers, according to the decreasing portion 103, pushing the burnt gas towards the boundary of the machine and expelling them through an expulsion opening depending on the geometry of the rotary bodies when they are in a predetermined angular position, which in the case treated ends at 630°. This operation is repeated cyclically. The particular geometry produces the operation is repeated cyclically. The particular geometry produce the birth of a second group of four chambers, always in central zone and with evolution the same as that already described, after a rotation of 180°, then during the expansion step of the first group of four is carried out the ignition of the mixture seconda group of four chambers. Like the process is repeated cyclically each 180° of rotation, as shown in figure 24, where the ciclo102 is followed by a cycle 106 after 180°. Is obtained thus a movement fluid of the motor obtained with a group of four combustioni contimeranee each 180°.

[0055] In particular, the above described mixture is injected by the out of the chamber nascing through an inlet duct obtained in each rotary body, of which duct, in figure 19, is visible the end of inlet 16 obtained on the surface 9', this surface 9' being the more inner of the surfaces curve the central portion 8. Furthermore, the ignition of the mixture can be operated with a source of scintille 17 arranged on the edge plane of the central portion 8, shown in figure 19, opposite with respect to the inlet port 16 and belonging to one of the rotary bodies perpendicular. Obviously, in an alternative exemplary embodiment, this source of scintille 17 can be arranged on one of the concave surfaces 9 and 9' and preferably on the surface

9'. In this case, this source 17 is capable of ignition the mixture contained in a chamber different from that would be used if the source 17 fosse arranged on the plane face. The opening expulsion of each four chambers is blocks always in the same position for each ciclo, whereby it is possible to arrange a colreader of unloading at this position. such a machine it could having the need of nonreturn valves arranged on the above described inlet duct adapted to block this duct during the step of combustion, whereas the apertures of unloading is open and chiudono cyclically for geometry and the kinematics of the rotary bodies. In particular, if is causes ignition the mixture at an angle higher than 90° and less than 180°, always riferendosis to the geometry of rotary body 1 described in figure 7, is not necessary the presence of the above described nonreturn valves because the inlet would be automatically closed by the relative position of the rotary bodies.

[0056] Figure 19A shows the opening end 139 opposite at the end 16 of the inlet duct passing in rotary body 19. this opening 139 is arranged on the curved end portion 14 and in position close to the rotation axis of rotary body 1.

[0057] In a possible exemplary embodiment, said internal combustion machine comprises a step of suction and compression of the comburent, previous to the expansion step owing to the combustion. this step of suction and compression can be done by a group of four chambers that at the same time aspirano a mixture of fuel and comburent from the outside for depression along a portion increasing the course of the volume, indicated as 110 in figure 25, followed by a portion deincreasing compression 111, adapted to bringing this mixture compressed zone central. before that the volume of each chamber containing the mixture is reduca to zero, in particular, after a rotation of the rotary bodies 540°, this mixture starts to trafilare through a duct in a second group of four chambers that starts to forming which are even at 540°. this trafiling is conclude after a rotation of 90° starting from the beginning the trafiling at the fine of the portion deincreasing 111. at this point, then after a rotation of 630°, is carried out rotary bodyre a spark seconda group of four chambers, containing the mixture compressa, ignition the mixture and carrying out a portion of expansion 102 followed by a portion of compression 103 the same as those described in figure 23. Such a machine, this way, carries out a group of four combustioni each 360°, differently from the previous example that ne carries out a group of four each 180°. Such an internal combustion engine is structurally more complex of the previous case since needs of valves arranged on the path of the mixture for allowing the correct operation.

[0058] In a preferred exemplary embodiment, said internal combustion machine comprises a step of suction and compression of the comburent that is carried out in sole two chambers, at the same time to an expansion step owing to the combustion in the restanti two chambers. A diagrammatical view of this operation is described in figure 26, where they are diagrammatically shown four rotary bodies 1 obtained according to the geometry described in figure 7, which define a group of four equal chambers diagrammatically shown with 120, 121, 122, 123, whose edge is a representation of a section of volume as described in the graphs of figures 23, 24 and 25. The amplitude angular of such chambers diagrammatically shown is proportional to the volume actual of the chambers as varies the angle of rotation of the rotary bodies. In the diagrammatical view representsto, in the chambers 121 and 123 is carried out the suction and the compression of the comburent, for example air drawn by the environment, whereas in the chambers 120 and 122 is carried out the expansion due to combustion and the expulsion of the burnt gas. The chambers 123 and 121 are connected respectively to the chamber 120 and 122 by a respective duct 130 and 131, on whose path is present a fuel injector 140 and a check valve 150 adapted to preventing the riflow of the burnt gas in the suction chamber 123. Such ducts 130 and 131 are obtained within the respective rotary bodies 1, having a first end 139, shown also in figure 19A, on the curved end portion 14 near the rotation axis and a second end coincident with the inlet 16. The comburent is drawn from the outside and sucked in the chambers 121 and 123 respectively by the ducts 132 and 133. The duct 132 has a first opening 134 at a central zone of the machine and a second opening 136 in a zone of maximum expansion, this opening comprising a check valve 138. Similarly, the duct 133 comprises a first opening 135 and a second opening 137 with valve 139. During the operation, the comburent is sucked in the chambers 121 and 123 through the ducts 132 and 133 using at first the apertures 134 and 135 and then the apertures 136 and 139 since apertures of inlet 134 and 135, shown with the opening 16 in figure 19, are closed automatically by the relative movement of the rotary bodies, after a first angle of rotation. Then such chambers reduce the just volume constringing the comburent, with the fuel coming from the iniectors 141 and 140, to trafilare compressed in the chambers 122 and 120 near the central portion where is causes rotary bodyre a spark 150 and 151 and is starts the combustion followed by expansion and expulsion of the burnt gas. The power supplied by the motor is adjusted changing the flow of comburent as inlet by the valves to farfalla 152 and 153. In this case, the course of the volume in the chambers is the same of that gia described in the graphical of figure 25.

[0059] A this machine, this way, carries out a couple of combustioni each 180°, at the same time to a couple of aspirations. This exemplary embodiment is consiglied because allows to obtain a movement fluid and needs of only nonreturn valves.

[0060] In a further exemplary embodiment, the machine according to the invention, is conformed as volumetric compressor capable of causing the suction of a gas from the outside and convogliarlo towards the centre of the machine compressinglo. The shape of each rotary

body 1, shown in figure 22 with dotted line, in this case, not comprises the central portion 8 shown above case of operating machine, being in change an empty space spherical defined completely by a surface central 18 on each rotary body 1. At least at one of such surfaces is present a light of delivery 16' that in case of machina motive coincide with the inlet 16 that is the end of a duct 19 passing in the rotary body and that porta out at the shaft 10. In this case it could being enough a single duct 19 since the above described empty space central is continually in communication with each rotary body. differently from the operating machine, the above described group of four chambers comprises four chambers nascing in the boundary of the machine in four positions fixed where it is located a colreader of suction. The course of the volume is shown diagrammatically in the graphical of figure 23 according to a speed of rotation negative, inverted with respect to that of the operating machine, carrying out a suction along the portion increasing 103, followed by the compression in the portion 102.

[0061] Obviously, the operation it could having speed of rotation opposite to that just described, second that, progressively that moves the rotation, the volume of the chambers increases according to a portion increasing similar to the portion 102 of figure 23 creating a depression in the chambers that thus aspirano the gas from the outside, this course increasing the volume is followed by a deincreasing 103 that compresses the gas porting it towards the centre.

[0062] Such second exemplary embodiment can be conformed to obtain a pump of liquid, whose rotary body 1 is described in figure 20, operating in the same way of the compressor already described, with the difference that since the liquid are incomprimible the above described duct 19, shown in figure 21, must comprise a plurality of apertures 16' oriented to the inner wall of each rotary body 1, adapted to keep in communication this duct 19 with the chamber of variable volume during the variation of this volume constringing the liquid to outflow progressively outwards.

[0063] Obviously, as in case of the compressor, this machine can work according to a speed of rotation positive or negative, according to it the towards of the flow of the liquid through the machine.

[0064] It is possible to, furthermore, to provide an exemplary embodiment of a machine according to the invention combining an operating machine obtained according to the above described first exemplary embodiment of a motor to combustion interna, and a compressor outer obtained according to the invention. this compressor outer can be a machine separated from the motor and connected by means of ducts of mandata, or can be obtained about the motor same, creating a compressor peripheral of which figures 28, 29, 30, 31 and 32 provide an example. In this last exemplary embodiment, the compressor peripheral comprises four rotary bodies 50 that remain external and coaxial to rotary bodies 1 of the motor that form the along with 12. The along with 12 of the motor, instead, remains in the compressor peripheral occuping the above described empty space central of the compressor, suitably enlarged. The four rotary bodies, then have the shape of a portion of shell spherical having thickness not very minimum and proportional to the volume of the variable volume chambers that is formed instantly between such rotary bodies 50. The delivery of the compressor peripheral, not shown in the figures, is connected to inlet of the motor, which are also not shown, located on the central portion by a duct in the rotary body so that the comburent pressurized is carried with the fuel at the central portion where is carried out the ignition of the mixture.

[0065] Figure 28 shows such an operating machine consisting the four rotary bodies 1, having rotational axes 11, such rotary bodies being contained in a containing structure 20 and integral and coaxial to the respective wheels conical 21, having axial cross section to arch in order to rotate about the containing structure 20, such wheels ingraning to each other and transmitting the moto. Outside to such wheels is provided a second wrapper spherical, not shown in the figure, which separates such wheels by the rotary bodies 50 that form the compressor peripheral obtained about the motor. Outside to such rotary bodies is present a third wrapper spherical 52 adapted to contain the whole machine.

[0066] Figure 29 shows an exploded view of such a machine where the block motor 12 is arranged at the centre and has four shafts protruding 10. this block motor 12 is contained in the containing structure 20. Coaxial to shafts 10 are mounted the gears 21 separated by the rotary bodies 50 of the compressor by the second wrapper spherical 51. The rotary bodies 50 of the compressor peripheral are closed in a third wrapper spherical 52. In the disegno are shown also the iniectors 160 adapted to inject the fuel in the inlet duct to the variable volume chambers not shown.

[0067] Figure 30 shows a partial view of an example of machine according to the invention assembled and already shown in figure 29 visible exploded. advantageously have not been disegnati the rotary bodies, therefore restano shown the beveled gears 21.

[0068] Figure 31 shows a perspective view of a compressor peripheral without the third wrapper shown in the two figures previous. In particular, are shown the rotational axes 11 and the rotary bodies 50.

[0069] Figure 32 shows the evolution time of the variable volume chambers present in the compressor peripheral. The volume of such chambers, indicated withs that must be from 400 to 406 changes according to a portion increasing followed by a ratto deincreasing, creating a depression and then suction along the portion increasing and the compression along the portion deincreasing. In particular, the drawings refer to configurations following obtained to range of rotation of 30°.

[0070] The description of which above one form esecutiva specific is capable of show the invention by the point of view concettual so that other, using the prior art, can

be changing and/or adapting in various applications this shape esecutiva specific without further ricerche and without moving away from each other by the concept inventive, and, then is intended that such adaptation and changes will be considerable as equivalent of the shape esecutiva exemplified. The means and the material to provide the various functions described can be being changes nature without for this come out from the field of invention. is intended that the expressures or the terminology used have object purely describedvo and for this not limitative.

Claims

1. A volumetric rotary machine for generating or transforming mechanical energy, **characterised in that** it comprises:

   - four rotary bodies rotating about a respective rotation axes, said four rotary bodies having said respective axes two by two perpendicular and two by two coincident but opposite to each other, wherein each rotary body has a recess that is penetrated by the two adjacent rotary bodies with axis perpendicular to each other, the rotary bodies with axis perpendicular to each other being mirror-like and counter-rotating, the rotary bodies with axes coincident and opposite being alike and counter-rotating, said recess penetrated by said rotary bodies creating at least four variable volume chambers, the volume of said chambers being responsive to the angular relative position between said rotary bodies, said chambers shrinking and expanding alternatively;
   - at least one fluid inlet and a fluid outlet present in at least one said inlet and outlet resulting in at least one position in said chambers;
   - a stiff containing structure arranged about said four rotary bodies, adapted to support said rotary bodies allowing their relative movement.

2. A machine, according to claim 1, wherein each rotary body of said four rotary bodies has said rotation axes, a plane face orthogonal to said rotation axis and having a spiral-shaped opening, a spherical portion defined by said plane face and by a couple of curved end portions separated by said rotation axes, an inner recess that originates from said spiral-shaped opening and plunges into said rotary body following a spiral shape, said spiral-shaped recess having transversal sections and axial sections consisting of portions of spiral, in particular, a spiral of Archimede, and being defined by walls having thickness substantially the same as the pitch of said spiral.

3. A machine, according to claim 2, wherein said curved end portions are symmetrical in a plane passing through said rotation axis and perpendicular to said plane face, said curved end portions being defined by points rotationally equidistant both from on said plane face and from a plane passing through said rotation axis.

4. A machine, according to claim 1, wherein each rotary body comprises a shaft portion opposite to said spiral-shaped opening and having an axis coincident with said rotation axes, means being provided for transmitting the movement between each shaft portion and an output shaft capable of providing mechanical power.

5. A machine, according to claim 8, wherein said motion transmitting means comprises a bevel gear integral to each shaft adapted to mesh with a corresponding gear integral to an adjacent shaft.

6. A machine, according to claim 1, wherein said volumetric rotary machine is an internal combustion machine and said inlet comprises at least one inlet duct, made in a respective rotary body, adapted to bring into said chambers a fresh fuel charge, in association with an ignition device located in a central portion of said rotary body, whereas said outlet comprises at least one outlet duct adapted to expel the burnt gas.

7. A machine, according to claim 6, wherein each rotary body of said internal combustion engine comprises a central portion, integral to a central part of said rotary body, having a plane face that is an extension of on said plane face of said rotary body and a couple of concave curved surfaces that join to on said plane face according to a first edge, said curved surfaces crossing along a second rectilinear edge incident to said first edge and passing through the rotation axis of said rotary body.

8. A machine, according to claim 6, wherein said outlet from two first chambers is connected to a respective inlet of two second chambers by at least one return duct, wherein said return duct comprises at least one valve adapted to obstruct in a synchronized way said return duct during the expansion owing to the combustion.

9. A machine, according to claim 1, wherein said volumetric rotary machine is a compressor for a fluid or a pump for liquid, wherein said compressor for a fluid or said pump for liquid has a central spherical recess defined by spherical surface portions belonging to each rotary body, said central recess communicating with said chambers for predetermined rotation angle of said rotary bodies.

10. A machine, according to claim 9, wherein said fluid

inlet in said chambers comprises at least one suction duct in at least one rotary body adapted to connect said central spherical recess with a fluid ready for suction, said duct having a first end connected to said spherical surface portion by a first opening.

11. A machine, according to claims 6 and 9, wherein said internal combustion machine is associated to a said compressor, said operating machine being connected to said compressor, wherein said compressor is obtained about said operating machine, said operating machine being arranged in said spherical recess of said compressor, each rotary body of said operating machine being co-axial and integral to a corresponding rotary body of said compressor.

Fig.1

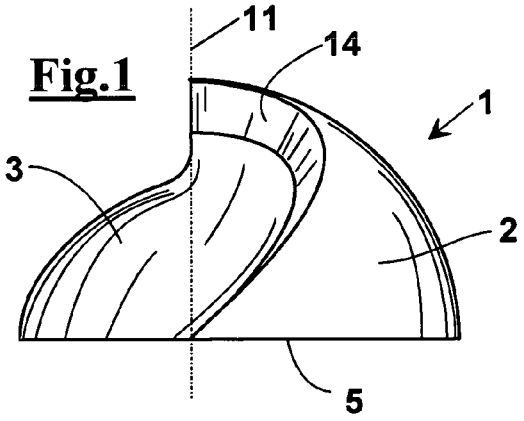


Fig.2

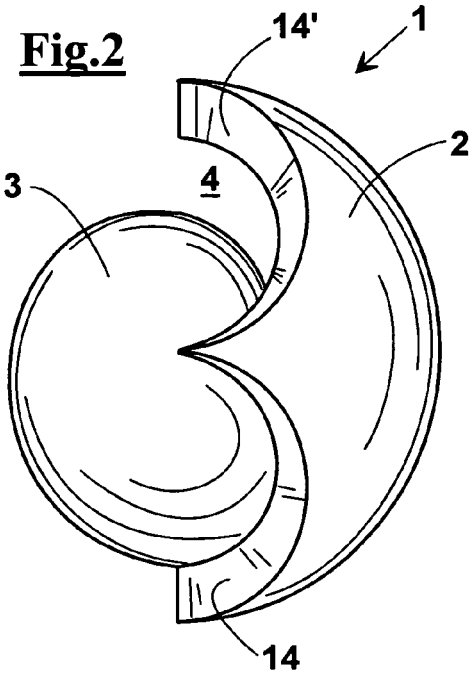


Fig.3

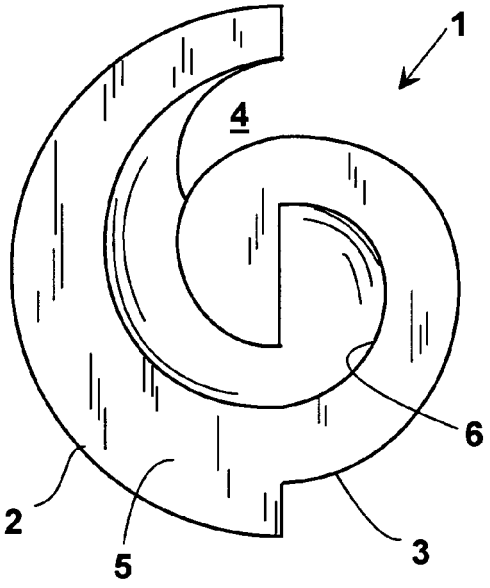


Fig.4

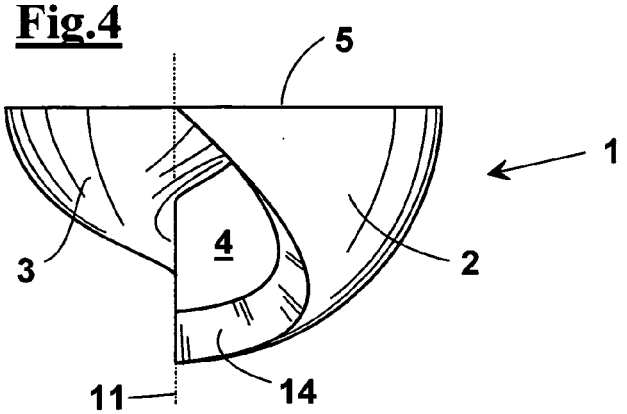


Fig.5

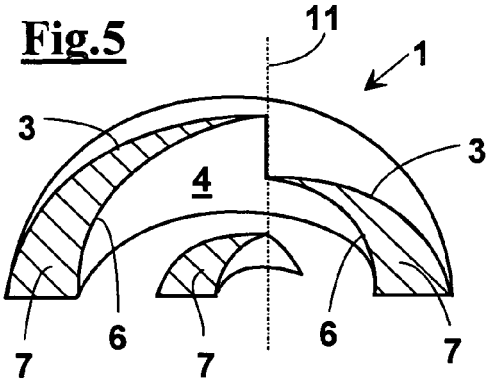


Fig.6

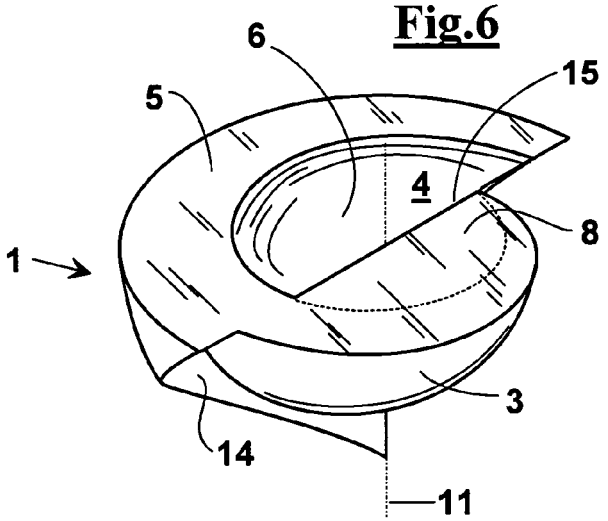


Fig.7

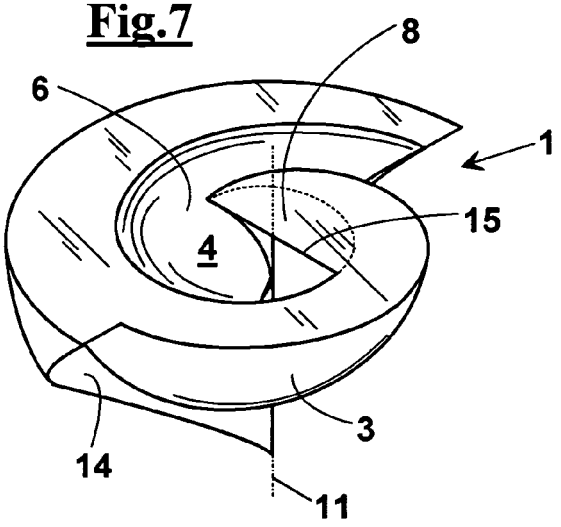


Fig.8

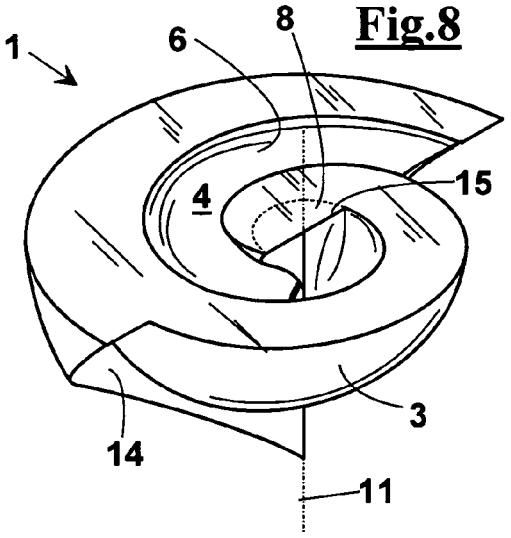


Fig.9

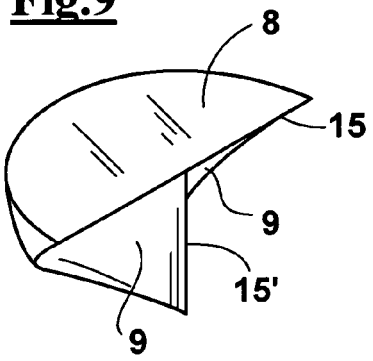
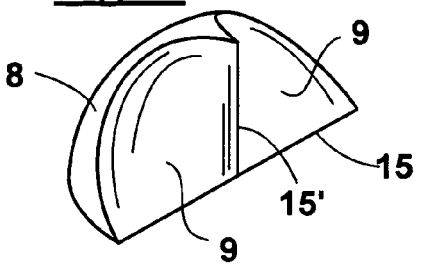


Fig.10



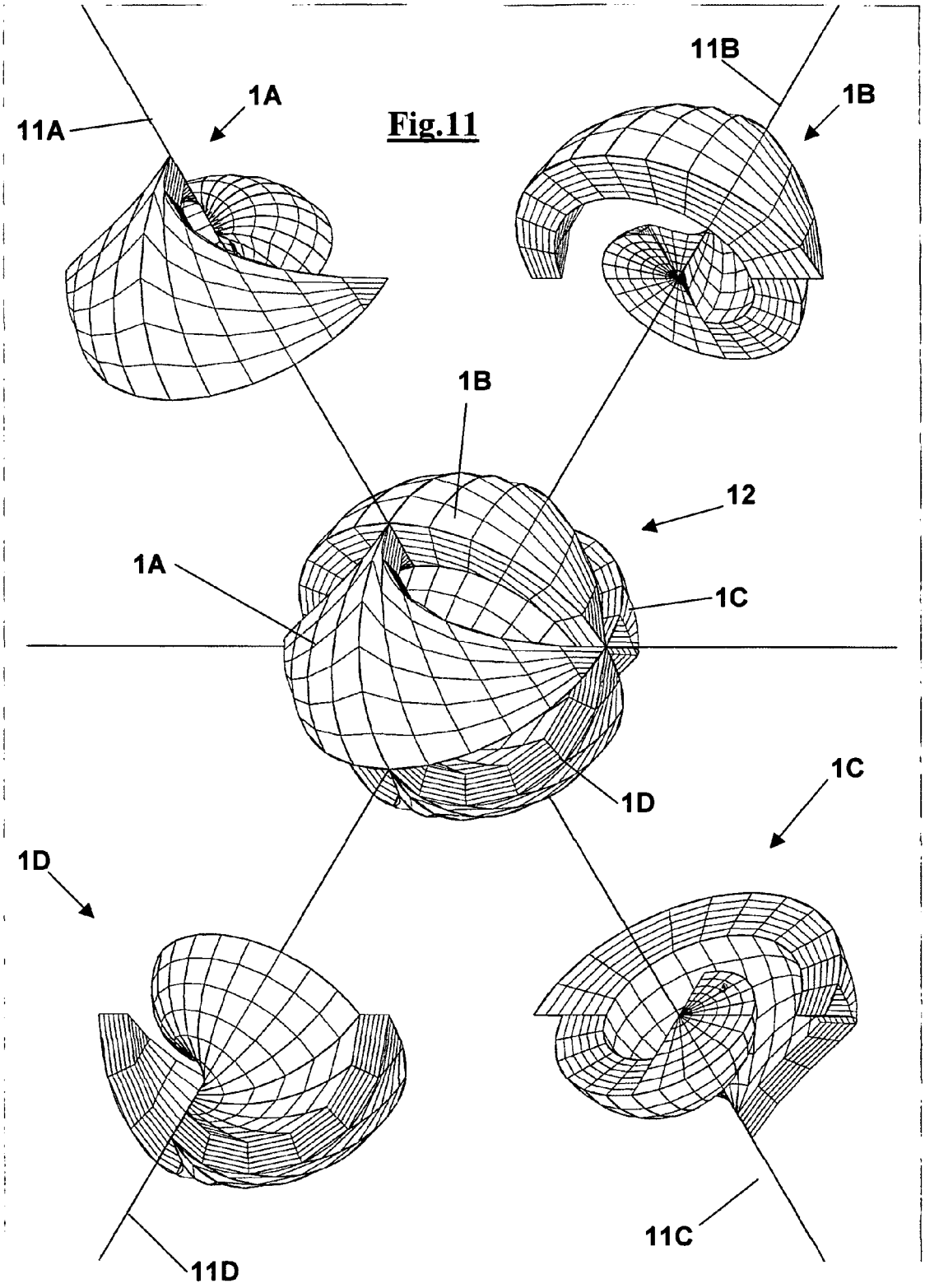


Fig.11

Fig.12

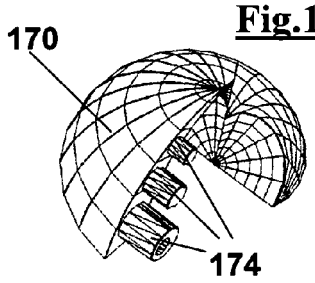


Fig.13

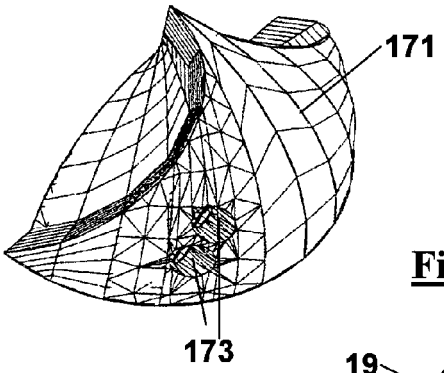


Fig.14

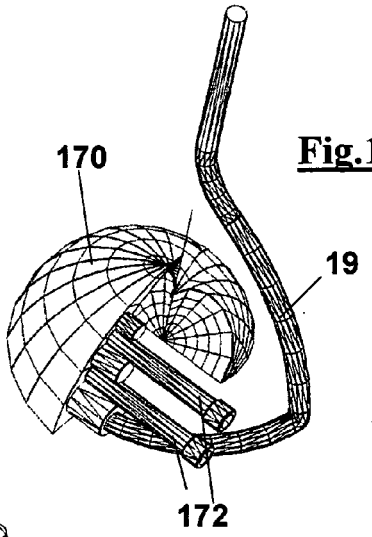


Fig.15

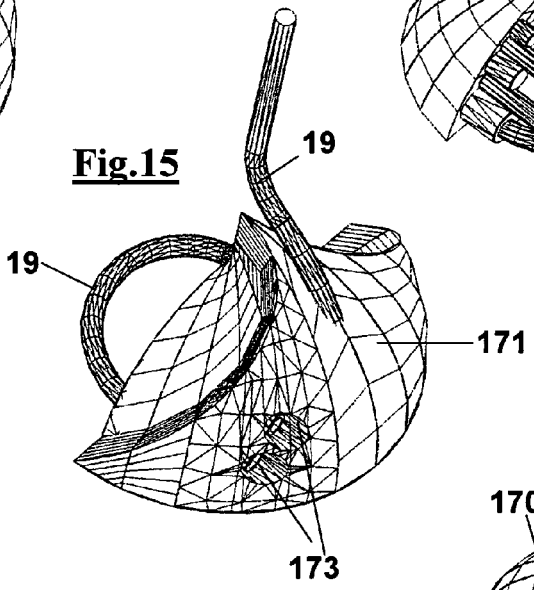


Fig.16

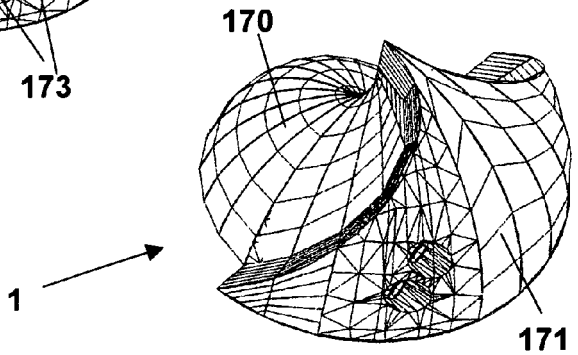


Fig.17

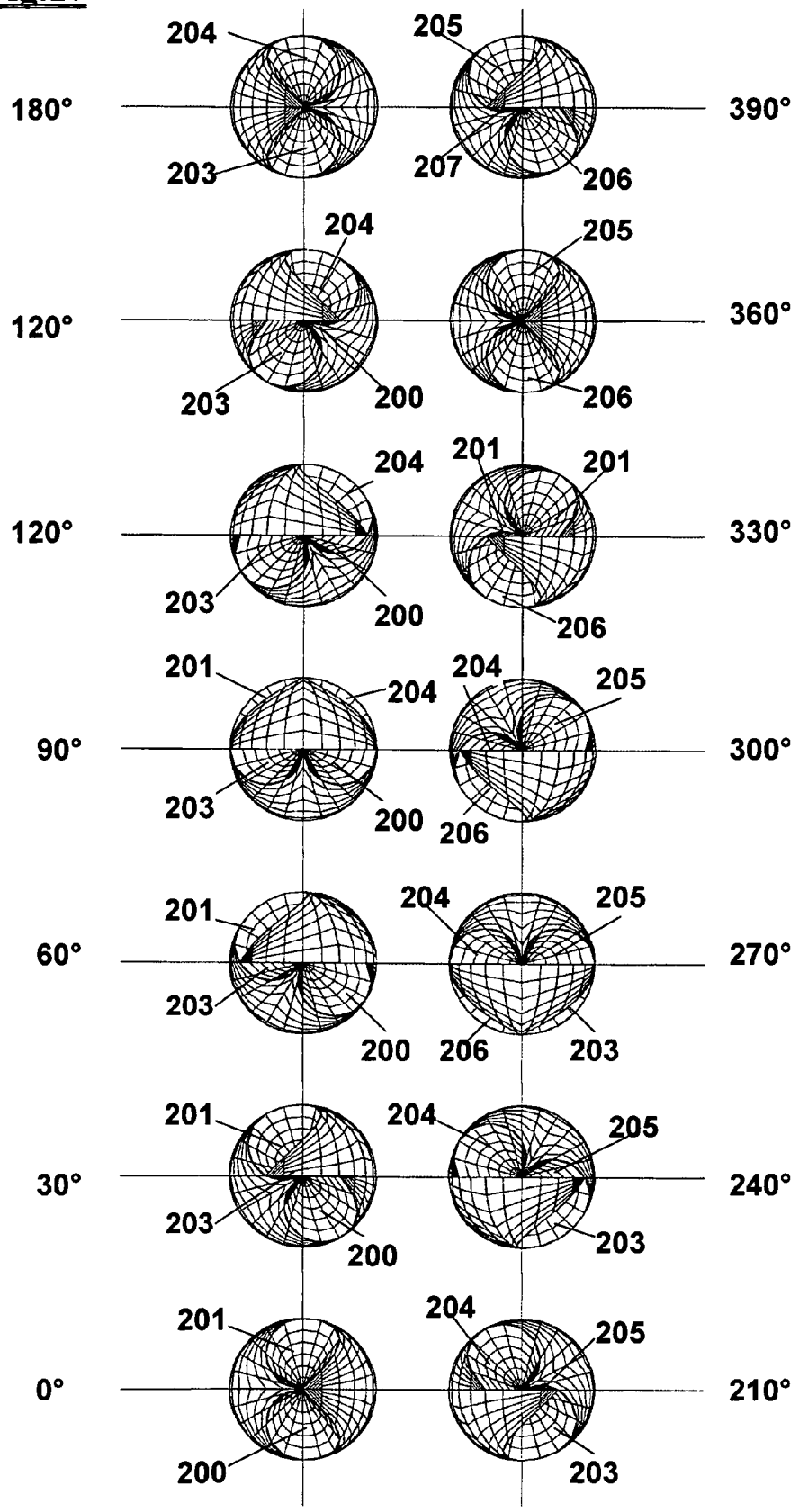

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Fig.18

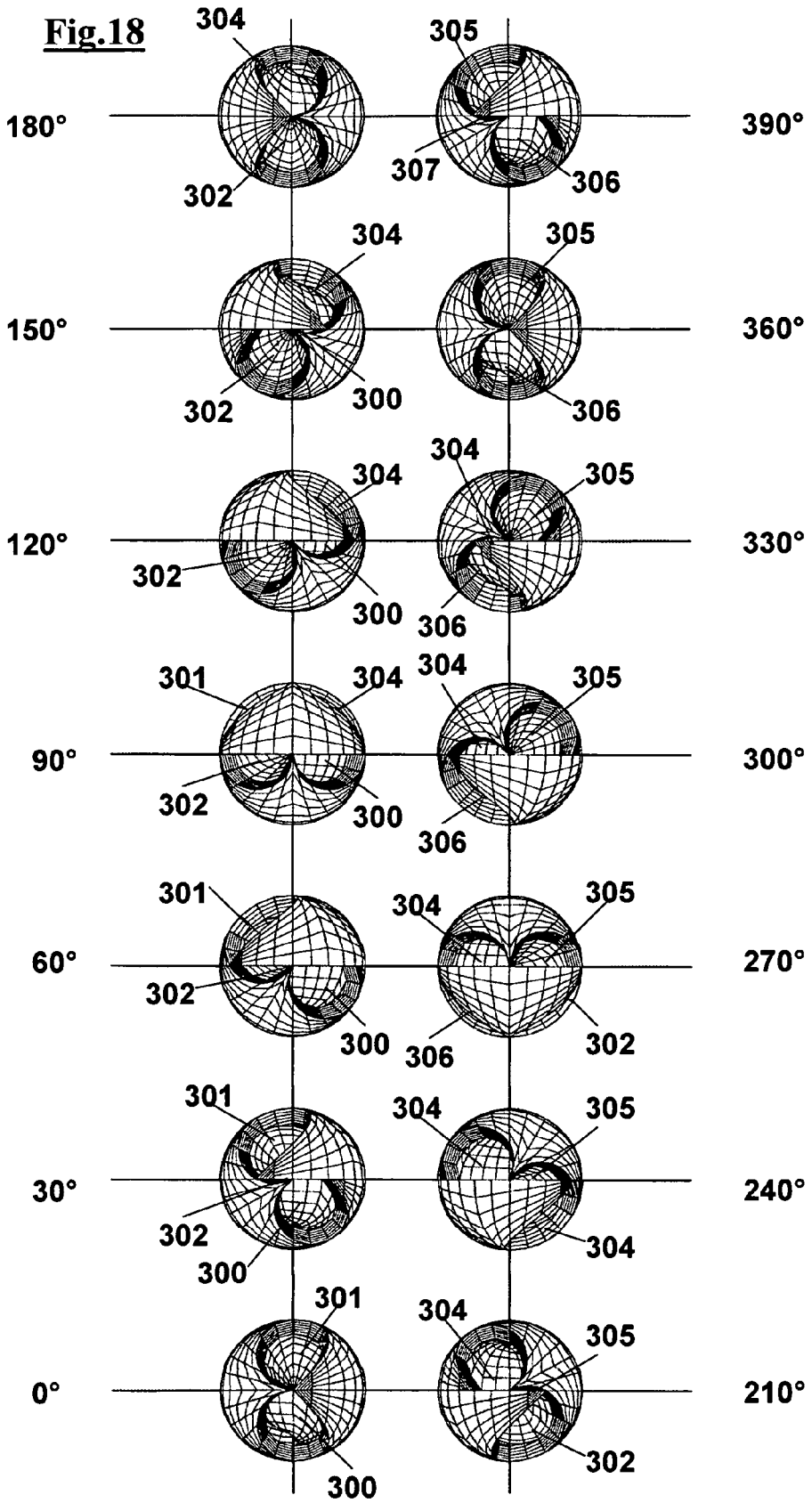

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Fig.19

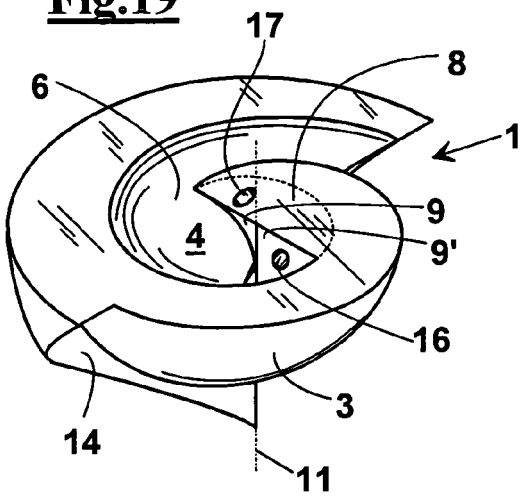


Fig.19A

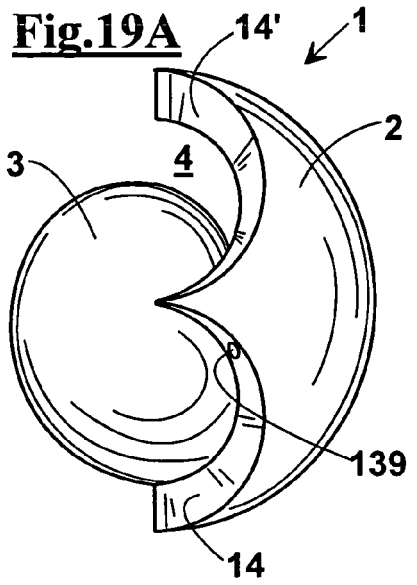


Fig.20

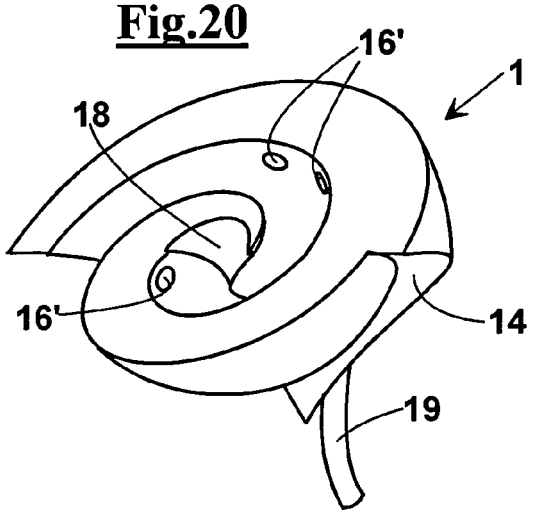


Fig.21

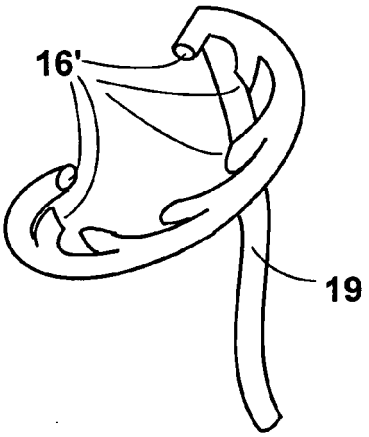


Fig.22

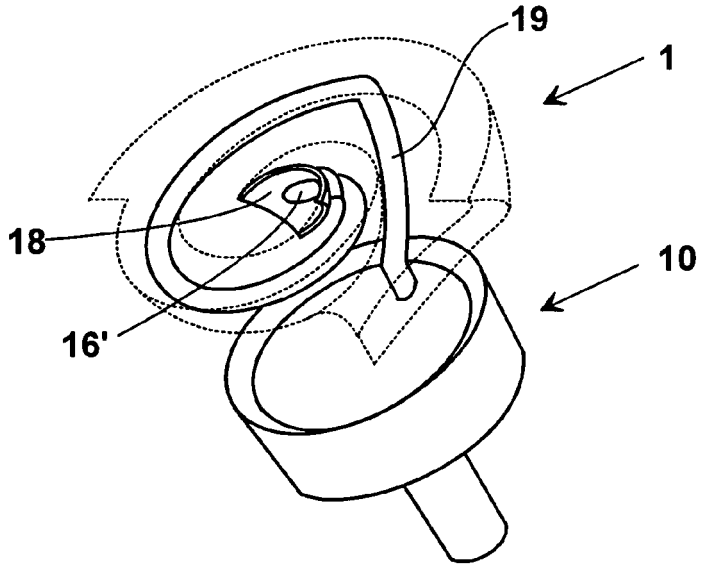


Fig.23

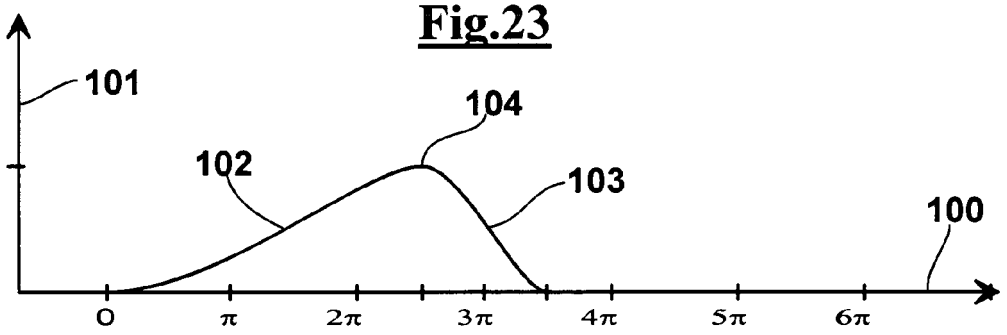


Fig.24

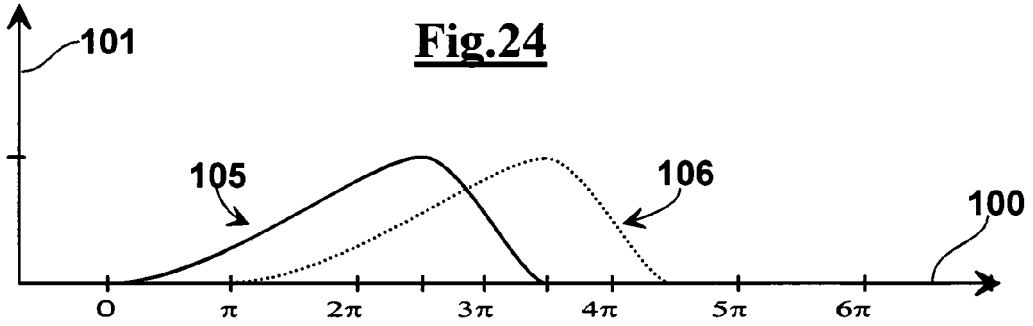


Fig.25

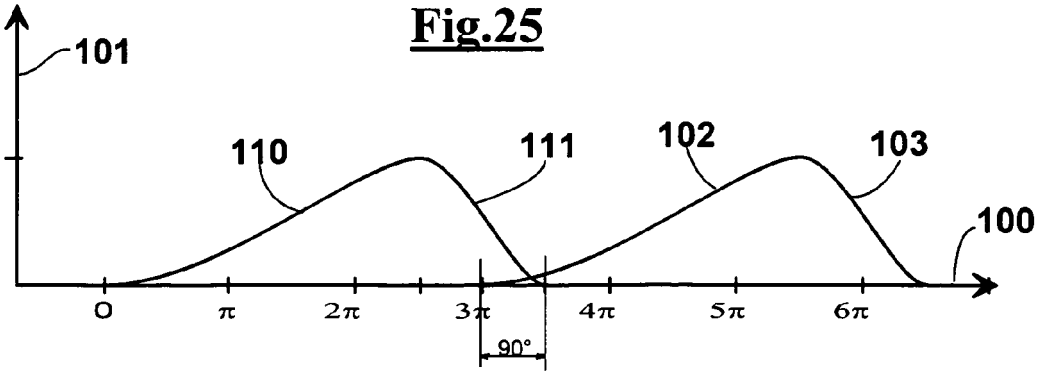


Fig.26

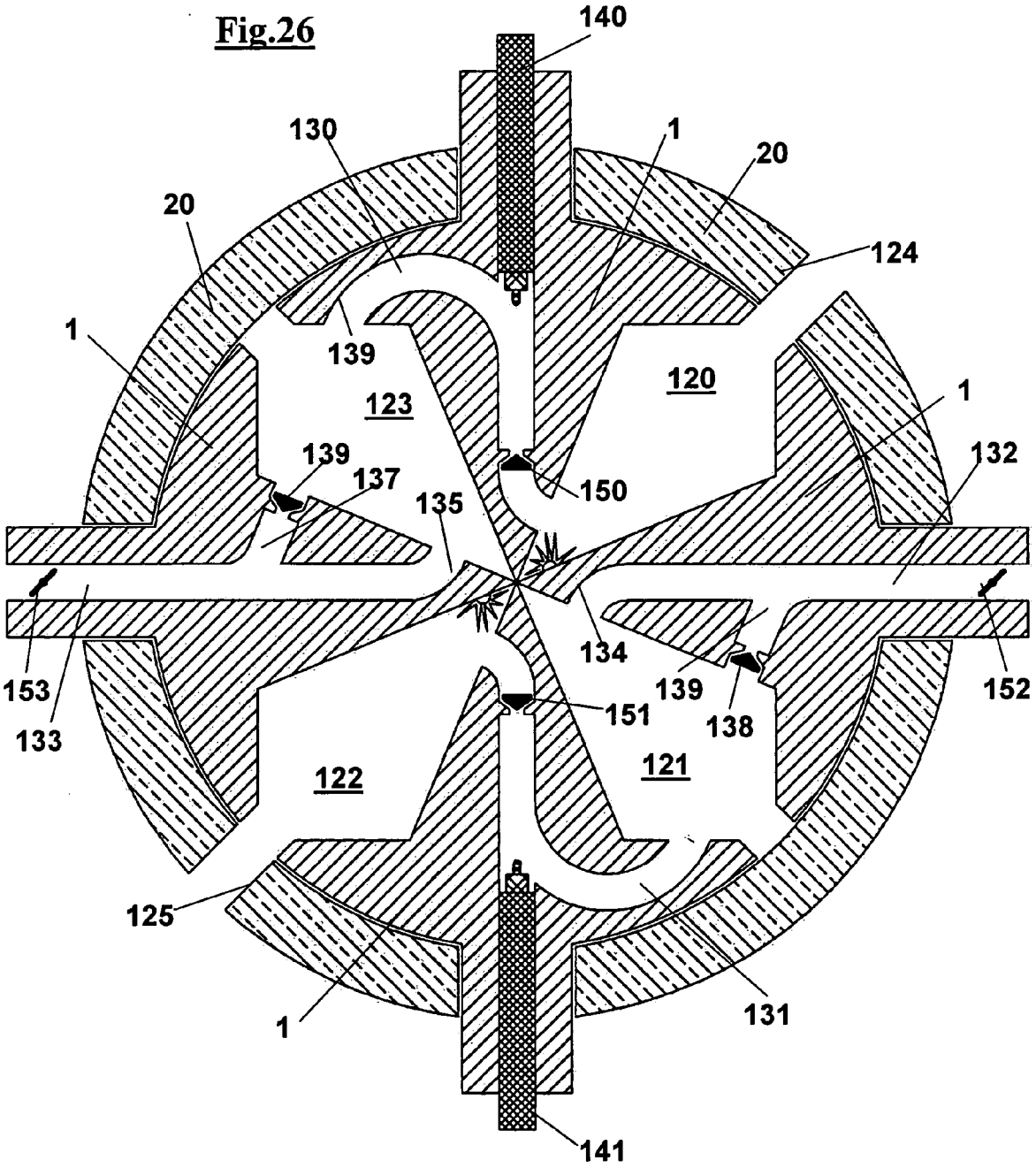

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Fig.27

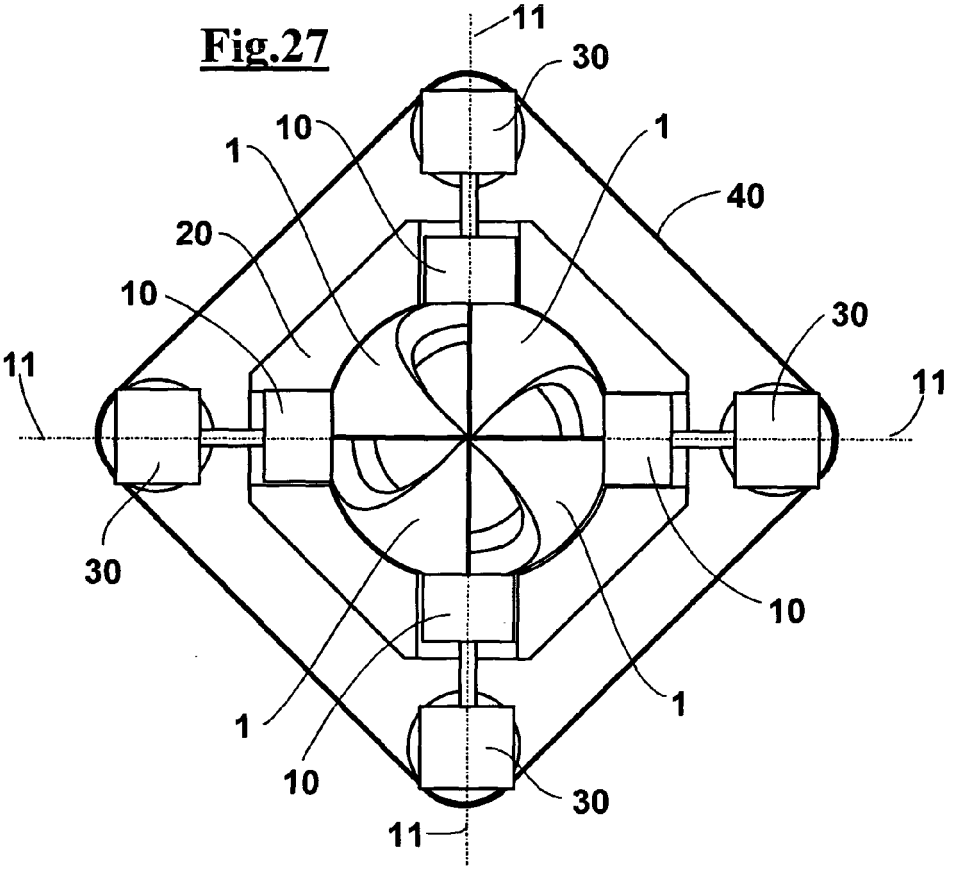

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Fig.28

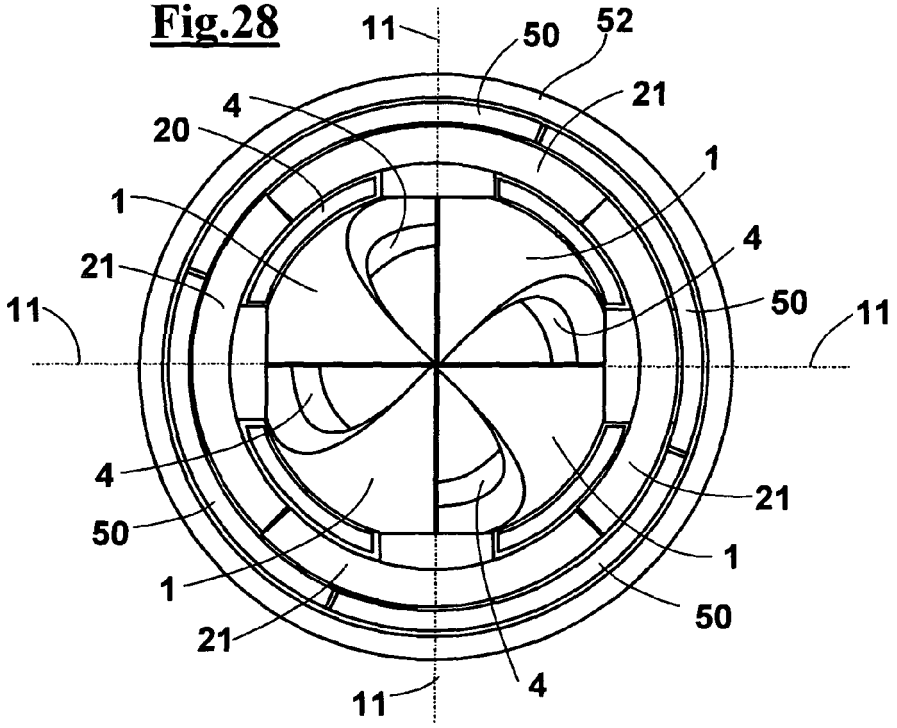

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Fig.29

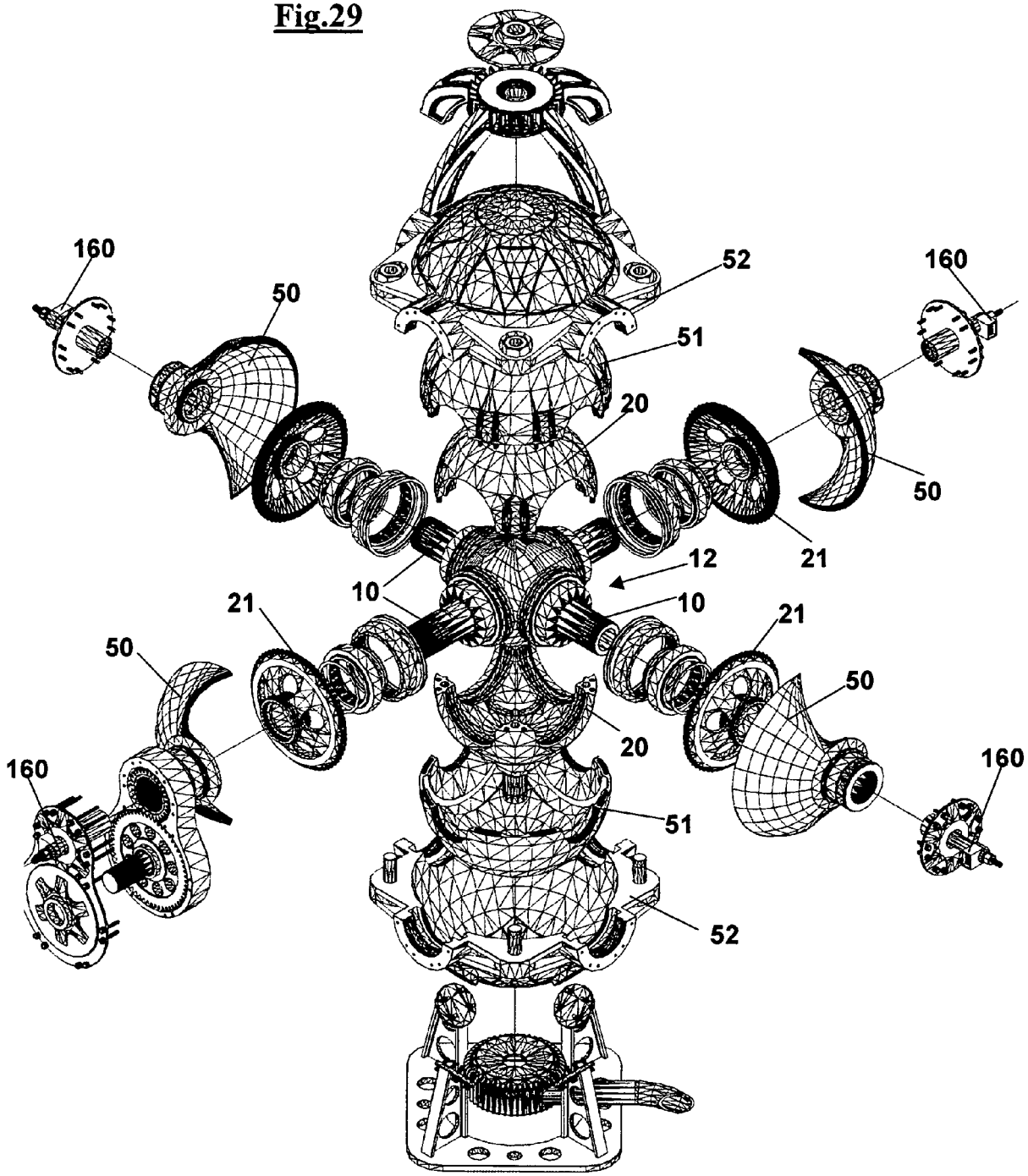


Fig.30

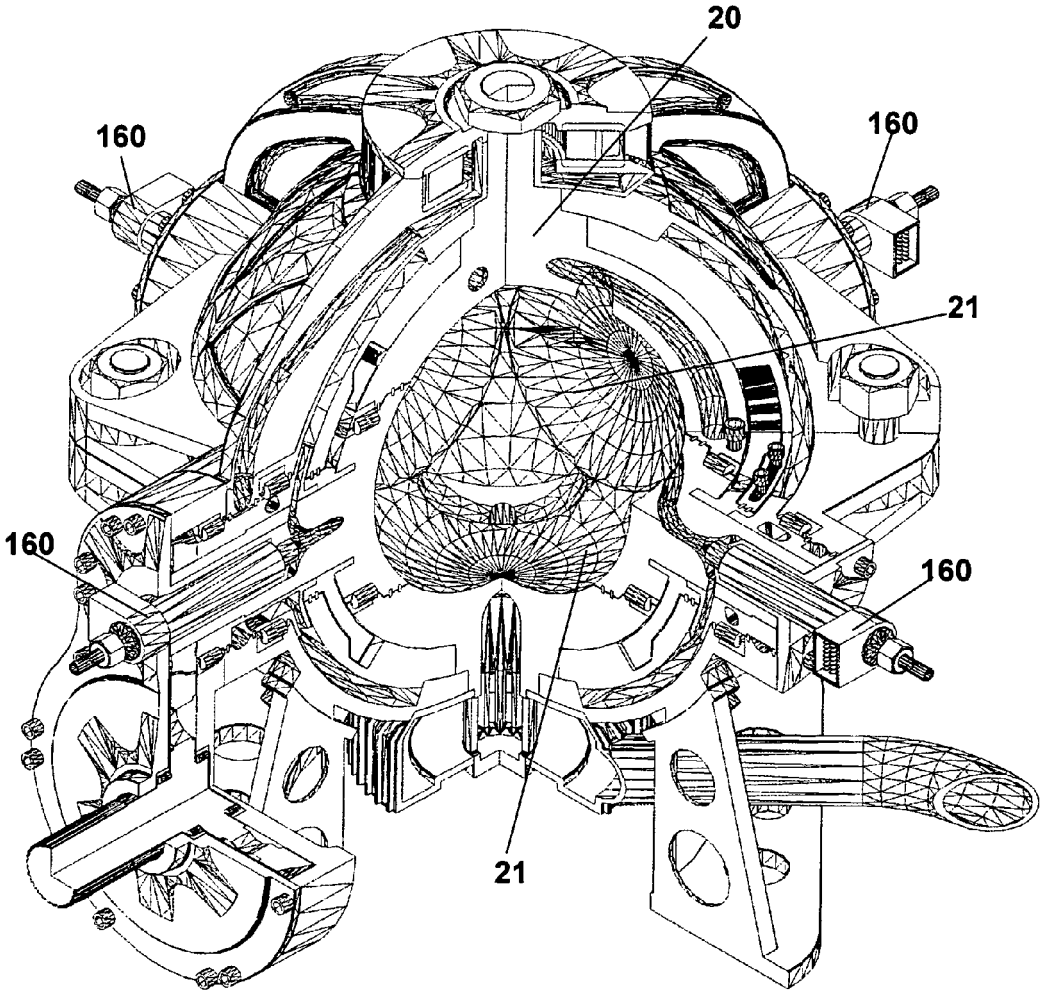


Fig.31

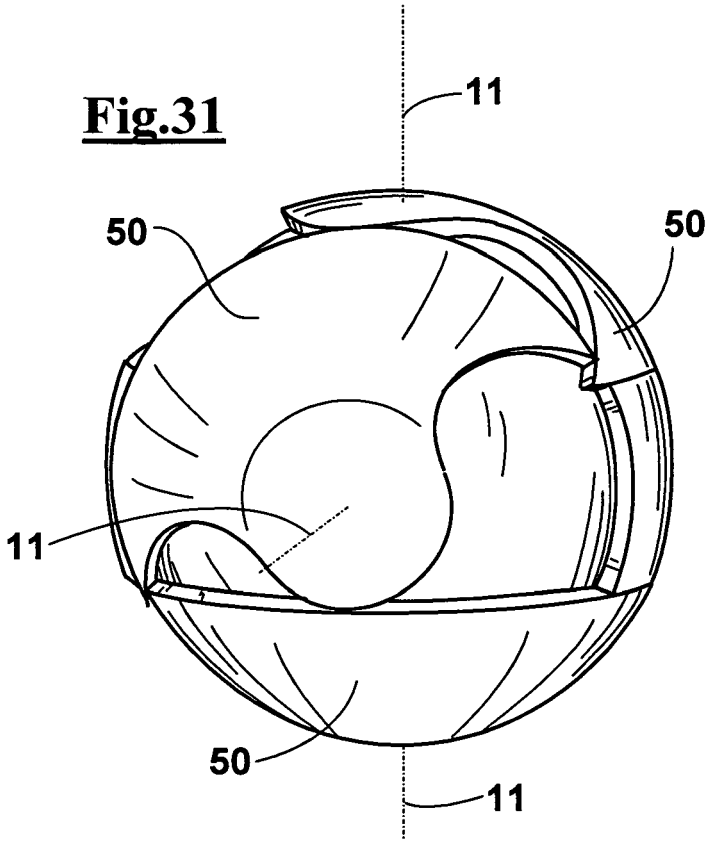
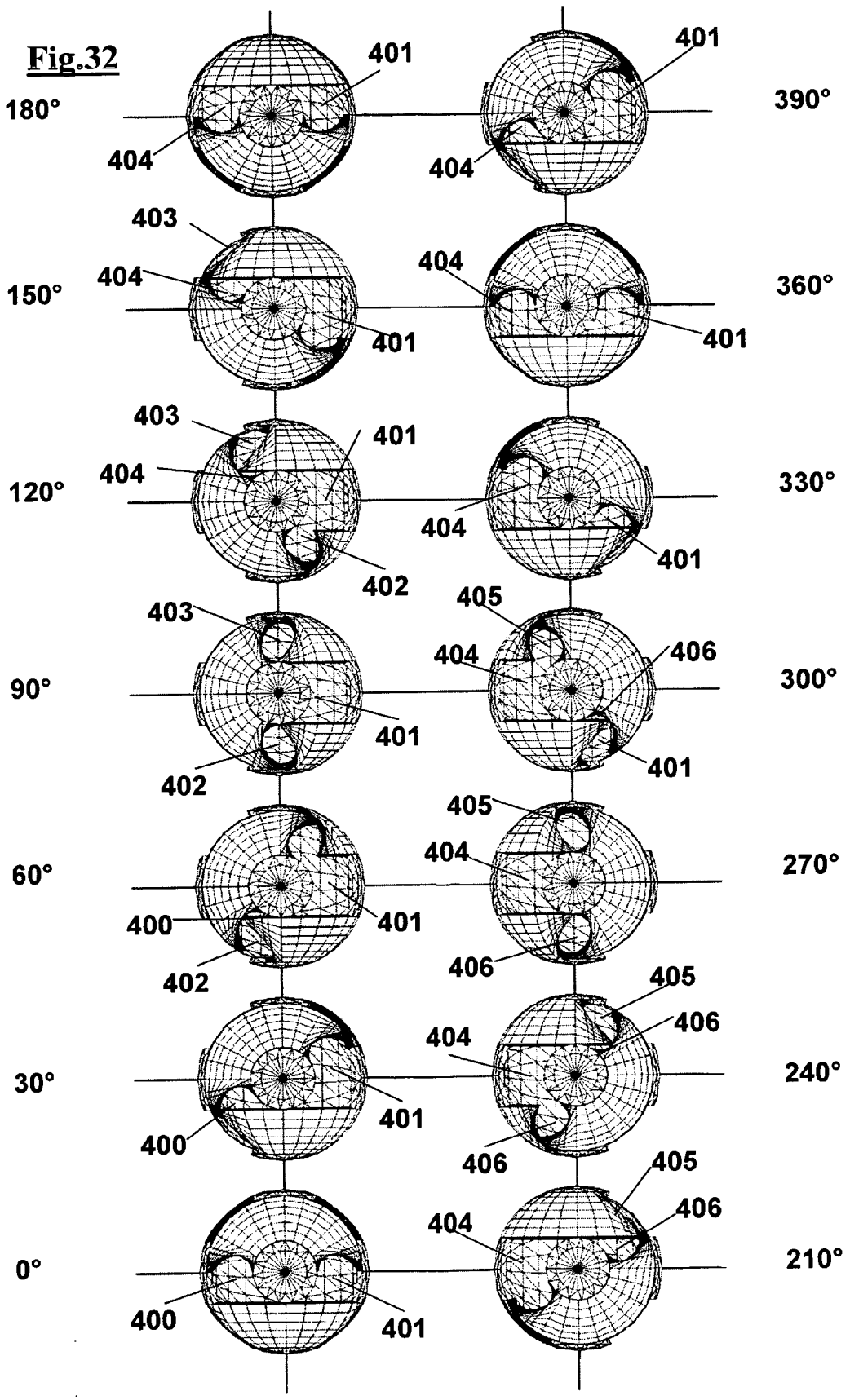


Fig.32


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European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 06 00 8645

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	DE 197 38 132 A1 (JAITNER LUTZ [DE]) 16 September 1999 (1999-09-16) * figures 7-12 * * claims 7,8 * * column 10, line 24 - line 32 * * column 14, line 30 - line 59 *	1,4,9	INV. F01C3/02 ADD. F04C18/52 F04C3/04
A	DE 26 39 760 A1 (NEHRING ANDREAS) 9 March 1978 (1978-03-09) * figures 1-17 * * claim 1 *	1	
A	JP 50 107311 A (JAPANESE) 23 August 1975 (1975-08-23) * figures 1-14 *	1	
A	DD 87 695 A (HERBERT GLADEWITZ) 5 February 1972 (1972-02-05) * figures 1-10 * * claim 1 *	1	

TECHNICAL FIELDS SEARCHED (IPC)
F04C F01C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	28 September 2006	Lequeux, Frédéric

CATEGORY OF CITED DOCUMENTS

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28-09-2006

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 19738132 A1	16-09-1999	NONE	
DE 2639760 A1	09-03-1978	NONE	
JP 50107311 A	23-08-1975	NONE	
DD 87695 A		NONE	

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