(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 307 515 A1**

(12) EUROPEAN PATENT APPLICATION

(21) Application number: **87201763.7**

(51) Int. Cl.4: **F01C 1/22**

(22) Date of filing: **17.09.87**

The title of the invention has been amended (Guidelines for Examination in the EPO, A-III, 7.3).

(43) Date of publication of application:
22.03.89 Bulletin 89/12

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

(71) Applicant: **Adiwinata, Sofyan**
Jalan Kebalen VII No. 3
Kebayoran Baru Jakarta(ID)

(72) Inventor: **Adiwinata, Sofyan**
Jalan Kebalen VII No. 3
Kebayoran Baru Jakarta(ID)

(74) Representative: **van der Veken, Johannes Adriaan et al**
EXTERPATENT P.O. Box 90649
NL-2509 LP The Hague(NL)

(54) Rotary internal combustion engine.

(57) A Rotary Internal Combustion Engine, including all types of vehicles and equipments or apparatus provided with Rotary Internal Combustion Engines and or Rotary Equipments/machines, which principally consist of arched bi-apex Rotor with arcaded inner surface Housing of epicyclic forms, and arched tri-apex Rotor with arcaded bi-lobed Housing of epitrochoidal form.
In such rotary engine, the Rotor **(21 of Fig.3)** is integrated its rotations with the rotations of the Maincrankshaft **(24 of Fig. 3)** through the intermeshing gears train **(37, 38, 47, 51, 52, 48 of Fig. 3)** by which the Rotor will be rotated or rotates in accordance to the basic speed ratio **(1 : 2 for the bi-apex Rotor and 1 : 3 for the tri-apex Rotor)** so thereafter the Rotor will rotates to the effective clearance during all relative rotations and maintain such permanent distance between the cooperating shapes of the stationary outer components and the rotating inner component, which distance will be use for inserting the proper sealing rings/elements of the same arched type of 180 degrees, so therefore such construction will be able to seal the working chambers accordingly, and avoiding any possiblity of direct contact between the Rotor arched apex portions and the arcaded inner Housing wall, so therefore such conditions will able to maintain the minimum wearing rate between the moving parts as mentioned above, to the normal rate for engine durability.
Further the pitch diameter of the Maincrankshaft is also constructed larger than the conventional pitch diameter of such similar engines and therefore will be able to avoid vibrations and carry more loads if required provided with the same dimensions of Rotor and its Housing.
Such larger pitch diameter of the Maincrankshaft is made possible because the pitch diameter and its intermeshing pinion gear are also made and constructed larger than the conventional design as caused by using larger gearing ratio of 3 : 2 instead of 2 : 1 for bi-apex Rotor and gearing ratio of 4 : 3 instead of 3 : 2 for the tri-apex Rotor type.

EP 0 307 515 A1

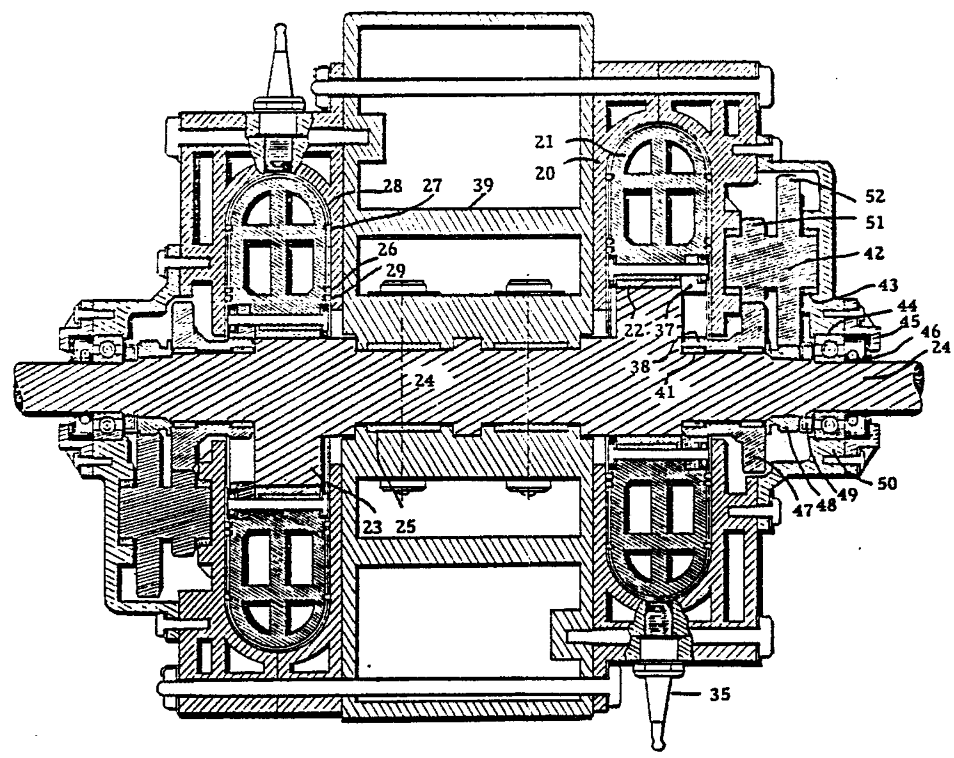

21
20
28
27
39
52
51
42
26
29
43
44
45
46
24
22
37
38
41
24
50
49
48
47
23
25
35

Fig. 3

" OEI " ROTARY INTERNAL COMBUSTION ENGINE

THIS INVENTION relates broadly to the art of **Rotary Mechanism** and more particularly relates to the art of **Rotary Internal Combustion Engine,** including all types of vehicle and equipments or apparatus provided with Rotary Internal Combustion Engines and or Rotary Equipments/machines, such as Rotary Compressors, Rotary Pumps, Rotary Cutting tools, or lathes, as well as Rotary System for Aircraft Engines or Vessels or any future flying crafts, using any kind of fuels suitable for such Rotary Internal Combustion Engines, either for land or sea or air transportations and for any other special purposes as broad as possible, which hereinafter for the purpose of simplicity will be referred to as " **Rotary Engine** ".

This invention is particularly related to the Rotary Engine which mainly will consist of **2 (two) principal types** as follows:

TYPE ONE :

A Rotary Engine in which **the outer component is a single stationary embodiment of epicyclic form** to have a special designed so called **"arcaded"** inner periphery Housing wall that defines an arcaded internal cavity, and with in which cavity is mounted **the inner component in the form of a rotating embodiment or ROTOR,** movable there around in a planetary motion, having **bi-apex portions** with **"arcaded"** outer peripheral surfaces.

TYPE TWO :

A Rotary Engine in which **the outer component is a stationary bi-lobed embodiment of epitrochoidal form,** to have a special designed so called **"arcaded"** inner periphery Housing wall that defines an arcaded internal cavity, and within which cavity is mounted the **the inner component in the form of a rotating embodiment or ROTOR,** movable therearound in a planetary motion, having **tri-apex portions** with **"arcaded"** outer peripheral surfaces.

Consistent with the foregoing object, the present invention has for a particular object to provide such Rotary Engine, in which **each principal -type** as previously mentioned will comprise of :

a. **2 (two) units** of stationary outer components or embodiments or Housings, having each of them axially spaced end walls and arcaded inner peripheral Housing wall defining an internal arched cavity, and:

b. **2 (two) units** of rotating inner components or embodiments or Rotor having each of them axially spaced end walls and arcaded outer peripheral surfaces, which Rotors are mounted within the internal arched cavities of the outer components and moveable therearound in a planetary motions during which the both facing shapes of the outer and the inner arcaded peripheral surfaces being cooperated to define upon suitable relative rotations, to form a plurality of variable volume working chambers within the said internal cavities of the outer components.

c. **1 (one) unit** of driveshaft train member, comprise of **one unit Maincrank shaft** which is constructed and machined so accurately having **2 (two) eccentrical hubshafts** made integrated with the Maincrankshaft with **2 (two) separate center axis** spaced apart each other **(180 degrees for the Type One and 180 degrees for the Type Two)** but parallel to the centerline of the Maincrankshaft axis, fitted thereon about which the said Rotor rotates or rotated on secured sleeve bearings or any other suitable type of bearings;

2 (two) units of intermeshing gear trains, integrating and controlling the Maincrankshaft and Rotor's relative rotative in accordance with each type **speed ratio such as 1 : 2 for the Type One and 1 : 3 for the Type Two** which means every one full rotation of the Type One Maincrankshaft (= 360 degrees), therefore the Rotor will rotate or rotated to a half rotation (= 180 degrees) and every one full rotation of the Type -Two Maincrankshaft (=360 degrees), therefore the Rotor will rotate or rotated to one third rotation (=120 degrees).

Each of the said intermeshing gear train will comprise **one internal ring gear** to be fixed or precasted within the centerpart of one side of the Rotor, and which is intermeshed with **2 (two) units of cluster gear assembly,** and each unit to comprise of two gears, which the first cluster gear assembly to have a hollow

shaft with suitable needle or ball bearing for free wheeling and fitted within one side of the Maincrankshaft, and the other one cluster gear assembly which is also comprise of two gears to be made and constructed within one separate axis shaft spaced apart -either from the Maincrankshaft centerline axis or from the other two centerlines of the eccentric hubshafts, which both ends of this second cluster gear assembly are mounted to the outer Housing wall of the outer component and the cluster gears assembly cover;
one final pinion gear which is secured and fixed within the Maincrankshaft by internal gearmeshed, having a coaxial axis with the centerline axis of the Maincrankshaft;
and therefore by this arrangement **the internal ring gear** (hereinafter will be referred to as **I.I.G.** an abbreviation of **Internal Involute Gear**) is intermeshed with **the first pinion gear of the first cluster gear assembly** (which hereinafter will be referred to as **I.I.G.P.** an abbreviation of **Internal Involute Gear Pinion**) and the second gear of the first cluster gear assembly (hereinafter will be referred to as **d** gear) will be intermeshed to the **first gear of the second cluster gear assembly** (hereinafter will be referred to as **c** gear) and **the second gear of the second cluster gear assembly** (herein after will be referred to as **f** gear) is intermeshed to **the final pinion gear** (hereinafter will be referred to as **e** gear) which is secured and fixed within the Maincrankshaft by internal gearmeshed, having a coaxial axis with the centerline axis of the Maincrankshaft;
and the gearing ratio or composition of each unit of gear is made and constructed to the fixed gearing compositions as hereinafter described or to the any other gearing composition to be based on the result of applying the RASER FORMULA as described in the former patent application at E.P.O. (European Patent Office) under Serial No. 86.201617.7 dated on 18th September 1986, which Raser Formula is as follows:

$$\frac{\text{I.I.G.P.}}{\text{I.I.G.}} - \frac{a}{b} = \frac{1}{2} \quad \text{for TYPE ONE Rotary Engine}$$

and

$$\frac{\text{I.I.G.P.}}{\text{I.I.G.}} - \frac{a}{b} = \frac{2}{3} \quad \text{for TYPE TWO Rotary Engine}$$

Whereas :
a/b quotient designating **rotational speed factor of the internal ring gear** to be increased or decreased within one revolution of the Maincrankshaft and which **a/b = I.I.G.P./I.I.G. x c/d x e/f.**
I.I.G.P. refers to the **Internal Involute Gear Pinion.**
I.I.G. refers to the **Internal Involute Gear.**
1/2 or 2/3, designating the **basic eccentric ratio of the Rotary Engine.**
c/d and e/f designating the gearing ratio of the intermeshing gears installed between the Rotor and the Maincrankshaft.
In case I.I.G.P./I.I.G. is bigger than its basic eccentric ratio therefore the Rotor must make an additional rotation and the I.I.G.P. or **the Pinion** rotates **in the same direction as the Maincrankshaft** and a/b quotient will be positive and the term (- a/b) is negative.
In case I.I.G.P./I.I.G. is smaller than its basic eccentric ratio, therefore the Rotor rotation must be reduced and the I.I.G.P. or **the Pinion** will rotate **in the opposite direction to the Maincrankshaft rotations** and a/b quotient will be negative an d the term (-a/b) is positive.

Accordingly, the present invention has for a particular object to provide such Rotary Engine, that the actual operation will be based on so called:

" OEI BASIC PRINCIPLE OF ROTARY ENGINE "

Every apex portions of each centerline or its continuation of either bi-apex or tri-apex Rotor, during all relative rotations, will repeat to the same positions and maintain the same distance to each of their Maincrankshaft axis centerpoint, provided such Rotor centerlines are rotating therearound an eccentrical circle having basic eccentric ratio of 1 : 2 for bi-apex Rotor and 2 : 3 for tri-apex Rotor, and to the speed ratio of one rotation of the bi-apex Rotor centerline to two revolutions of the Maincrankshaft, or one rotation of the tri-apex Rotor centerline to three

revolutions of the Maincrankshaft, and that the rotations of the Rotor and Maincrankshaft are to the same directions. Consistent with the foregoing object, this invention has for a particular object to provide such Rotary Engine, that based on the mentioned above " OEI Basic Principle of Rotary System ", therefore any apex portion of either bi-apex or tri-apex Rotor can be made and constructed in an **"arched form",** for which a 180 degrees angular arched apex portion of Rotor Form is suitable for the purpose of installing an arched sealing elements which will enable to solve the conventional corner leakage such as in the Wankel Type of Rotor.

Accordingly, the present invention has for a particular object to provide such Rotary Engine, an improved form of the inner surface of the outer component, that in order to cooperate with the above mentioned 180 degrees arched apex portion of Rotor, therefore the inner surface of the outer component is made and constructed also in **"arched form"** and in such a continuously and only in accordance to the relative rotations of the Rotor, in this case, to be exact, is in accordance to the relative positions of the **arched apex portion of the Rotor** during its relative planetary motions therearound the eccentrical hubshaft provided with the proper speed ratio as previously mentioned.

Such continuous arched form of the inner surface of the outer component will form such a specific, somewhat like **"arcaded inner Housing wall"** or **"arcaded internal cavity"** within the outer component.

And in order to obtain the proper working chamber which is in accordance to the required effective compression ratio, therefore the outer surface of the Rotor, between two adjacent arched apex portions will be constructed and shaped to form a specific, somewhat like **"arcaded outer surface of the Rotor"** which shapes connecting the two adjacent arched apex portions of the Rotor will be relatively decreased from 180 degrees arched shape at each apex portion of the Rotor to become minimum in the middle depended to the determined angular shape of the outer surface of the Rotor and such form of cooperating shapes between the outer and inner component will function as the working chambers with effective compression ratio, or as intake chamber and outlet chamber which within each side surfaces will be sealed by means of including sealing elements or rings along the side surfaces of the Rotor and engaged with the Rotor apex sealing rings.

Consistent with the foregoing object, it is a further object of the invention to provide such Rotary Engine, that the internal arcaded surface of the outer component or the inner Housing wall surface has therefore 2 (two) kind of relatively **"Rotational Shape"** depended from which axis centers it will be measured, which explanation is as follows:

a.FIRST SHAPE :

as it can be measured from the axis center of the Maincrankshaft; from which this First Shape has only arched shape of perfect 180 degrees at the positions where the centerlines of the Rotor meet or over lined the vertical and horizontal crossing -lines through the axis center of the said Maincrankshaft.

Thereafter, between every two perfect arched shape of 180 degrees, the shape of the inner Housing wall will be decreased to minimum in the middle depended to the "arcaded form" of the inner Housing wall of each typical Rotary Engine.

b.SECOND SHAPE:

as it can be measuredfrom the relative positions of the rotating center-point of the Rotor centerlines which rotates therearound its basic eccentric circle of each typical Rotary Engine, from which said above relative rotating position points, the Second Shape has always perfect arched shape of 180 degrees during its relative rotations, provided that the Rotor will maintain its rotations to the speed ratio as mentioned in the OEI Basic Principle of Rotary System. Such situation as mentioned above will enable the arched 180 degrees apex portion shape of Rotor to perfectly macth to the specific arched form of the inner Housing wall as previously mentioned, which condition will be maintained accurately, precisely subject to the punctuality of the Rotor rotation to its basic speed ratio.

Consistent with the foregoing object, the present invention has for a particular object to provide such Rotary Engine, that such specific form of the arcaded internal surface of the outer component or the inner Housing wall form, can be made and constructed alternatively by a special cutting and shaping tools or equipments which comprise of the same Rotor (which is made by conventional system) but provided with proper cutting tools attached or secured on each arched apex portion of the said Rotor, which Rotor will be rotated by

means of intermeshing gear train to the same construction as previously described and to the fix composition as hereinafter will be explained.
Because the special cutting equipment as mentioned above has its Rotor Rot ation Form exactly the same with the inner Housing wall form, therefore with proper adjusted clearance, such special equipment will accurately cut and form the proper specific shape of the required inner Housing wall including the effective clearance in between for the sealing rings or sealing elements engagements..
The other supports and relevant constructions of such special equipment is in accordance to the normal known engineering method and therefore is not mentioned in this application for simplicity purposes.

Accordingly, the present invention has for a particular object to provide such Rotary Engine, to have each one or more intake and outlet passage/s within the suitable positions of the outer component, which means for communicating the concern working chambers, either with or without valves, for alternately feeding sufficient air or mixture of fuel air into its proper variable volume working chambers that are defined during its relative rotations between the cooprating shapes of the inner and outer components and flow it out after the stage of ignitions and combustions has been concluded perfectly.

It is further object of the invention to provide an improved relationships of ignitions means of the spark plug type or fuel injection type depended to the specific type of fuel will be used to operate such Rotary Engine. Such spark plu or fuel injector can be located within the suitable positions of the compression chamber of the outer component.

It is further object of the invention to provide such Rotary Engine, that in order to install and assemble the Rotor with arcaded outer surfaces into the cavity of the arcaded outer component or the Housing, therefore the outer component or the Housing is constructed and divided into 2 (two) or more separate parts, either through the centerlien of transverse plane cut or through the middle of the circumferential line of the outer component, so thereafter will be available a sufficient space to allow the said Rotor to be inserted into the cavity of the Housing and which-after all related parts will be assembled back properly.
Such fixing or securing the separate parts may be requiring certain sealing elements or gasket to be applied for leakage preventions.

It is further object of the invention to provide such Rotary Engine that between the cooperating shape surfaces of the inner and outer arcaded component will be constructed sufficient clearance for the purpose of including suitable selaing rings .
Therefore in order to match with the above conditions, the arched apex portion of Rotor will be provided with sufficient grooves for a half-ring sealing elements installation seat.
Because such effective clearance can be maintained permanently during all relative rotations of the Rotor, therefore the said above half ring sealing elements will be able to seal properly and prevent any leakage of compression from one into another working chambers without receiving any excessive pressures from the arched apex portions of Rotor, excepts its own adjusted spring power, and therefore could maintained the normal permissible wearing rate in order to obtain the normal life or durability of such Rotary Engine.
In connection with the above matter the invention contemplates the chrome plated inner Housing wall surfaces and chrome plated Rotor rings for the purpose to obtain the smooth and hard chrome surface which has a good affinity for lubricating oil and to reduce the wearing rate significantly. Further the half ring sealing elements can be constructed to have longer legs in order to continue and engage properly the side surface sealing rings for perfect sealing purposes, for which several alternative model of rings and seat position can be introduced.
It is further object of the invention to provide such Rotary Engine having bi-lobed of epitrochoid Housing, that beside using the arched tri-apex Rotor as has been described previously, such engine may have another model of similar tri-apex portion Rotor but with 6 (six) lobed of arcaded outer surface forms as follows:
Such Rotor is still comprise of three arched apex portion of the same size but the outer arcaded surface between every two adjacent apex portions will be made and constructed accurately into 2 (two) lobed of arcaded outer surface Rotor form which form will be exactly following the 2 (two) lobed arcaded inner surface of the Housing wall, which is used for the compression chamber in the conventional model, and thereafter the both cooperating shapes of the inner Housing wall surface and the new model of 6 (six) lobed arched outer surface of Rotor can match perfectly each other because each cooperating shapes have the same surface form when they meet within the compression stage and after every exhaust stage or just beginning the intake suction stage, and therefore such typical special design is able to prevent the interfere of the exhaust gases into the intake chamber during the intake suction stage.
Except for the compressor or pump units/machines, for Rotary Engine, therefore must be provided with a channel within the arcaded inner surface of the Housing wall, which channel will function as the compression chamber, where the size as well as the form of such channel will be based to the effective

compression ratio as may required for such Rotary Engine. Alternatively a similar channel can also be constructed between the two adjacent arched apex portion within the arcaded outer surface of said Rotor, which channel will function to limit the effective compression ratio. By such condition, therefore a sliding valve is needed and installed between the intake and outlet passage ports which valve is so constructed for the purpose to prevent any leakage of the exhaust gases interfering into the adjacent intake chamber accordingly.

Such sliding valve is controlled by special cam to be made and constructed either integral with the Maincrankshaft or by separate camshaft. As constructed in the conventional model such channel may also be constructed without provided by any sliding valve for proper operation.

It is further object of the invention to provide such Rotary Engine that in order to be able to control the Rotor's Rotations in accordance to its each typical basic speed ratio, therefore an intermeshing gear train will installed between the Rotor and the Maincrankshaft, and in order to obtain maximum space efficiency and minimum gearing ratio, therefore the composition of such intermeshing gear train will be fixed to the arrangement as hereinafter described:

a. For the TYPE ONE Rotary Engine with bi-apex Rotor:

1. **The ring gear** to have its pitch diameter of **3 : 2 (three to two)** with its intermeshing **Pinion gear** which means that the ring gear pitch diameter is one and one half times larger than the pitch diameter of the Pinion Gear or in the other words has one and one half times as many gear teeth **(or I.I.G.P./I.I.G. = 2/3).**

2. **The second gear of the first cluster gear assembly (= d gear)** which is intermeshed to the **first gear of the second cluster gear assembly (= c gear)** to be based on **gearing ratio of c/d = 1/2** which means that the **d gear** has its pitch diameter **two times** of the pitch diameter of the **c gear,** or in the other words has two times as many gear teeth.

3. **The second gear of the second cluster gear assembly (= f gear)** and which is intermeshed to **to the final pinion gear (= e gear)** which is secured or mounted within the Maincrankshaft by internal gearmeshing and having its axis center coaxial with the Maincrankshaft axis centerline, to be based on **gearing ratio of e/f = 1/2** which means that the **f gear** has its pitch diameter **two times** of the pitch diameter of the **c gear,** or in the other words has two times as many gear teeth.

4. Before the fixing of the ring gear to the center part of Rotor side, proper adjustment can be made by turning slightly the ring gear to meet the manufacturing tolerances in order to maintain permanently the effective clearance limit.

5. The **Type One Rotary Engine** has its **basic eccentric ratio 1 ; 2** which means that **every one revolution of the Maincrankshaft, therefore the Rotor has to rotate for (1 - 1/2) x 360 = 180 degrees.** By gearing ratio of **I.I.G.P./I.I.G. = 2/3,** therefore **every one revolution of the Maincrankshaft, therefore the Rotor will rotate to (1 - 2/3) x 360 = 120 degrees,** which is not sufficient to meet its basic speed ratio of 180 degrees.

Therefore by installing the said intermeshing gear train within one revolution of the Maincrankshaft, the said Ring Gear will be accelerated by : **180 - 120 = 60 degrees which means a/b quotient = 1/6 Pinion rotation is to the same direction of the Maincrankshaft,**

$$\textbf{Therefore}\quad a/b = \text{I.I.G.P.} / \text{I.I.G} \times c/d \times e/f$$

$$1/6 = 2/3 \times c/d \times e/f \quad \text{therefore}$$

$$c/d = 1/2 \quad \text{and} \quad e/f = 1/2$$

b. For the TYPE TWO Rotary Engine with tri apex Rotor:

1. **The ring gear** to have its pitch diameter of **4 : 3 (four to three)** with its intermeshing **Pinion gear** which means that the ring gear pitch diameter is one and one third times larger than the pitch diameter of the Pinion Gear or in the other words has one and one third times as many gear teeth **(or I.I.G.P./I.I.G. = 3/4).**

2. **The second gear of the first cluster gear assembly (= d gear)** which is intermeshed to **the first gear of the second cluster gear assembly (= c gear)** to be based on **gearing ratio of c/d = 1/3** which means that the **d gear** has its pitch diameter **three times** of the pitch diameter of **c gear,** or in the other words has three times as many gear teeth.

3. **The second gear of the second cluster gear assembly (= f gear)** and which is intermeshed to **the final pinion gear (= e gear)** which is secured or mounted within the Maincrankshaft by internal gearmeshing and having its axis cenetr coaxial with the Maincrankshaft axis centerline, to be based on **gearing ratio of e/f = 1/3** which means that the **f gear** has its pitch diameter **three times** of the pitch diameter of the **c gear,** or in the other words has three times as many gearteeth.

4. Before fixing the ring gear to the centerpart of the Rotor side, a proper adjusment can be made by turning slightly the ring gear to meet the manufacturing tolerances in order to maintain permanently the effective clearance limit.

5. **The Type Two Rotary Engine has its basic eccentric ratio of 2 : 3** which means that **every one revolution of the Maincrankshaft, therefore the Rotor has to rotate for (1 - 2/3) x 360 = 120 degrees.** By gearing ratio of **I.I.G.P./I.I.G. = 3/4,** therefore **every one revolution of the Maincrankshaft, therefore the Rotor will rotate to (1 - 3/4) x 360 = 90 degrees,** which is not sufficient to meet its basic speed ratio of 120 degrees.

Therefore by installing the said intermeshing gear train within one revolution of the Maincrankshaft, the said Ring Gear will be accelerated by **: 120 - 90 = 30 degrees which means a/b quotient = 1/12** **and the Pinion rotation is to the same direction of the Maincrankshaft rotations.**

Therefore a/b = I.I.G.P./I.I.G. x c/d x e/f

1/12= 3/4 x c/d x e/f therefore

c/d = 1/3 and e/f = 1/3

It is further object of the invention to provide such Rotary Engine that **different alternative variation of the intermeshing gear train** are made possible by formulating the alternative compositions to be based on the **RASER FORMULA** as described in the former application and amenmend under serial No. 86.201617.7 (European Patent Office, 18th September 1986) which is written as follows:

For TYPE ONE:

I.I.G.P./I.I.G. - a/b = 1/2 , and thereafter
a/b = I.I.G.P./I.I.G. x c/d x e/f.

For TYPE TWO :

I.I.G.P./I.I.G. - a/b = 2/3 and thereafter
a/b = I.I.G.P./I.I.G. x c/d x e/f
whereas:
I.I.G.P. refers to the pitch diameter of Internal Involute Gear Pinion.
I.I.G. refers to the pitch diameter of the Internal Involute Gear.
a/b refers to the rotational speed factor of the ring gear or I.I.G. to be increased or decreased within every one revolution of the Maincrankshaft.
c/d refers to the gearing ratio of the second gear of the first cluster gear assembly (= c gear) to the first gear of the second cluster gear assembly (= d gear).
e/f refers to the gearing ratio of the final pinion gear which is secured within the Maincrankshaft and having the axis center coaxial to the Maincrankshaft axis centerline (= e gear) to the second gear of the second cluster gear assembly (= f gear).
1/2 refers to the basic eccentric ratio for Type One Rotary Engine.
2/3 refers to the basic eccentric ratio for the Type Two Rotary Engine.
For example :

If it is desired to have an increased pitch diameter of the Maincrankshaft for the purpose of stronger hubshaft giving more load capacity, therefore the pitch diameter of such maincrankshaft can be increased if the pitch diameter of the Internal Involute Gear Pinion and therefore also the pitch diameter of Internal Involute Gear as well, be increased to the extend that sufficient space for side sealing elements is provided properly and therefore the intermeshing gear train composition can be determined as follows :
Assuming the I.I.G.P./I.I.G. is 4/5 for the Type Two Rotary Engine, therefore the other gearing ratio (c/d and e/f) can be formulated as follows:

I.I.G.P./I.I.G = a/b = 2/3 or 4/5 - a/b = 2/3

a/b = (+ 2/15) which means that the Pinion rotation is in the same direction to the rotation of the Maincrankshaft.

a/b = I.I.G.P./I.I.G. x c/d x e/f or

2/15 = 4/5 x c/d x e/f or

c/d x e/f = 2/15 x 5/4 = 1/6 Or equal to 1/2 x 1/3

therefore:

c/d = 1/2 and e/f = 1/3.

Such condition as mentioned above can be explained as follows :
By fixing I.I.G.P/I.I.G. = 4/5, therefore within every one revolution of the Maincrankshaft, the Rotor will be rotated to (1 - 4/5) x 360° = 72° which means is not sufficient to reach its basic speed ratio which is based on its basic eccentric ratio of 2 : 3 (= 1-2/3 x 360° = 120°) and therefore the Rotor rotation must be accelerated for 120° - 72° = 48° or in other words 48° : 360° = 2/15 which is the same to **a/b quotient** as mentioned previously.
Therefore the gearing ratio for the other c/d and e/f are obtainable the same way as it has been described.

It is a further object of the invention to provide such Rotary Engine that in order to obtain the correct gearing composition for the smooth and proper operation of the Rotary Engine, therefore **the eccentricity which is the actual distance between the Rotor and Maincrankshaft centerpoints MAY NOT BE CHANGED, and the Rotor rotation must be kept to the same direction of the Maincrankshaft rotations.**
Changing the eccentricity will also change the dimension of the Rotor and therefore will require adjustment of the Housing and different Intermeshing gear train compositions thereof, and the changing of the Rotor rotation to opposite of the maincrankshaft rotations will of course causing the changing of different Housing Form.
Therefore only the I.I.G.P. or Pinion Gear may change its rotation to the opposite of the Maincrankshaft direction subject to that the I.I.G.P./I.I.G. is smaller to the basic eccentric ratio (1 : 2 for Type One Rotary Engine and 2 : 3 for Type Two Rotary Engine).
As already known such I.I.G.P./I.I.G. which is larger than the basic eccentric ratio of each type Rotary Engine, therefore the Pinion Gear will rotate to the same dir ection of the Maincrankshaft rotations.

Further the invention has a particular object to provide such Rotary Engine that as conventionally constructed both end of the Maincrankshaft and the Housing will be provided with proper rubber seal elements and suitable ball bearings, and within the hollow shaft of the first cluster gear assembly will be provided with suitable needle bearing or if the space is sufficient with suitable ball bearing at both side, and the both end of the shaft of the second cluster gear assembly will be provided with suitable sleeve bearing or suitable ball bearing depended to such neccessity of the construction or manufacturing requirements, including all suitable spacer thereof and suitable keys as well.

It is further object of the invention to provide such Rotary Engine that beside using the said above intermeshing gear system to control and to fix the punctuallity of the rotation timing, the said above Rotary Engine will be provided with **epicyclic gear trains or planetary gears system,** in which system, the ring gear or **I.I.G.**, will be intermeshed to the Pinion gear or **I.I.G.P.**, which is made integral and combined in one hollows -shaft with **the arms of the planetary gears system.**
Within the said above **arm of the planetary gear system,** will be mounted **3 (three) arm-gears on such equal distance,** and each of them to have own shaft for free wheeling, which said all gears will be intermeshed to **one unit of ring gear** which is fixed and secured within the outer part of the Housing, as well as intermeshed also to **the final pinion gear.** Therefore in such **planetary gears system or epicyclic gear trains,** there between the Maincrankshaft and each of the Rotor will be provided with **2 (two) units of Internal Involute Gears, one which is fixed or mounted to the Rotor and the other is fixed or mounted to the outer part of the Housing. hereinafter both will be referred as the inner or outer ring gear.** Kinematically only one intermeshing gear is required for the arm but by using three gears there will be more balance available and the load can be equally divided among the gears and therefore will make possible the utilization of the smaller or thinner of gears.

The gearing ratio of such planetary gears system can be formulated by using the RASER FORMULA in order to obtain the **a/b quotient** and then by normal known engineering method the following gears and outer ring gear cán be formulated accurately.
For example :
The Type One with bi-apex Rotor to have the pinion and inner ring gear ratio of 2 : 3, therefore the a/b quotient is 1/6 (=Raser Formula). Therefore :

$$1/6 = 2/3 \times \frac{1}{\text{outer ring gear/arm gear} \times \text{arm gear/pinion}}$$

$$1/6 = 2/3 \times \frac{1}{\text{outer ring gear /pinion}}$$

therefore the gearing ratio of outer ring gear : pinion = 4:1
As the superposition of the planetary gear always added+1 therefore the outer ring gear : final pinion = (4 - 1) : 1 = 3 : 1, and the arm gear : the final pinion = 1 : 1.
Assuming the final Pinion gear has pitch diameter of 40 mm, therefore the armgear will also 40 mm and the outer ring gear will be 3 x 40mm = 120 mm, provided the I.I.G.P. : I.I.G. is fixed to 2 : 3.

For the tri-apex Rotor to have the pinion and inner ring gear ratio of 3 : 4 therefore the a/b quotient is 1/12 (=Raser Formula). Therefore :

$$1/12 = 3/4 \times \frac{1}{\text{outer ring gear/arm gear} \times \text{arm gear/pinion}}$$

$$1/12 = 3/4 \times \frac{1}{\text{outer ring gear/pinion}}$$

after minus by superposition factor of planetary gear system Therefore: Outer ring gear : Final Pinion = (9-1) : 1 = 8 : 1.
Assuming the final Pinion gear has pitch diameter of 40 mm, therefore the outer ring gear would have its pitch diameter 8 x 40 = 320 mm, which is actually not practical compare to the size of the rotary engine. Therefore to solve this problem, the invention further object is to provide such Rotary Engine that the armgear will be constructed in cluster gear assembly consisted of one larger diameter gear which will be intermeshed to the final pinion gear to **the gearing ratio of 2 : 1** which means that the arm gear has pitch diameter **twice** as much the pitch diameter of the final pinion.
The second gear of the said cluster gears assembly which is significantly smaller in pitch diameter, is intermeshed to the outer ring gear to the **gearing ratio** of **1 : 4** which means that the pitch diameter of the outer ring gear will be 4 (four) times larger than the second gear of the cluster gear assembly, while the arm is to have the arm gear shaft suitable for the purpose of holding the arm gear and free wheeling the arm gears. By such arrangement the gearing ratio after added by the superposition of such pl anetary gear system is fixed to (8 + 1) : 1 = **9 : 1** which means suitable for the tri-apex Rotor having I.I.G.P.:.I.I.G. = **3 : 4**
Assumingthe pitch diameter of the final pinion is 40 mm, therefore the first gear of the cluster gear assembly is 2 x 40 = 80 mm, and the second gear of the said cluster gear assembly, 40 mm (= final pinion) and the outer ring gear is 40 x 4 = 160 mm.
Therefore, the planetary gear system has more advantages compare to the conventional system, such as stable rotations, smaller gear etc.
Further and more specific objects of the invention will be apparent from the explanation given in regard with the accompanying drawing which:

Figure 1, is the CUT AWAY view of the whole conception of **the TYPE TWO** Rotary Engine, provided with **Rotor** which is of **tri-apex type arcaded outer surface,** and each of the apex is of **180 degrees arched form** and the **intermeshing gears is fixed to gearing ratio of 1 : 3 and 1 : 3** for the purpose of maximum space efficiency and minimum gearing ratio as mentioned previously, which the **I.I.G.P./I.I.G. is fixed to ratio of 3/4,** and in which Rotary Engine will consist of **one unit Maincrankshaft made and constructed with 2 (two) integrated eccentric hubshaft having each own axis centerline parallel to the Maincrankshaft centerline axis and to the distance of 180 degrees each other equally.** The other components such as **the flywheel, cooling fan, etc.,** are provided as conventionally manufactured, except that special for the Type Two with tri-apex Rotor, the Rotary Engine will not use any valves for its intake and outlet cycles.

Figure 2 & 3, the cross & longitudinal view of TYPE ONE Rotary Engine which **the bi-apex arcaded Rotor** is provided with I.I.G.P **(38)** and the I.I.G. **(37)** to the fixed gearing ratio of **2 : 3** and apex sealing rings **(28)** side surface sealing elements **(27)**, o-ring for oil scrapping **(26 & 29)** which Rotor **(21)** is rotating therearound the Maincrankshaft **(24)** having eccentric hubshaft **(23)** secured on sleeve bearing **(22 & 25)** and which Maincrankshaft is secured to the engine Housing **(20)** through the ball bearing **(44)** at both ends of the shaft **(24)** and sealed by rubber seals **(46)** hold to the intermeshing gears cover **(50)** and protected by rubber seal cover **(45)**, which Rotor and the said Maincrankshaft is integrated its rotation through the intermeshing gears train, comprise of Internal Involute Gear **(37)** which is fixed or secured to one side of the Rotor and intermeshed to the first cluster gear assembly having a hollow shaft provided with needle bearing **(41)** at both ends, for free wheeling within the Maincrankshaft, comprises of the first pinion gear **(38)** or Internal Involute Gear Pinion **(I.I.G.P.)**, and the second gear **(47)** which is intermeshed to the first gear of the second cluster gear assembly **(51)** made integrated in one shaft **(42)** with the second gear of the secon cluster gear assembly **(52)**, which both shaft ends are mounted to the outer part of the Housing **(20)** and the inner part of the intermeshing gear cover **(50)** through the sleeve bearings **(43)**, which gear is intermeshed to the final Pinion gear **(48)** which is secured to the Maincrankshaft by gearmeshed and fastened by pinion nut **(49)** having coaxial axis centerline with the Maincrankshaft axis centerline, and which intermeshing gears train to have fix gearing ratio of **1 : 2 (51 gear : 47 gear = 1 : 2 and the 48 gear : 52 gear = 1 : 2,)** so therefore theintermeshing gears train will able to give additional rotation to the Rotor by 1/2 x 1/2 x 2/3 = 1/6 or equal to 60 degrees for every one revolution of the Maincrankshaft so thereafter the Rotor will be rotated to its basic speed ratio of 1 : 2 or equal to 180 degrees (which is the total amount of 60 degrees plus 1-2/3 x 360 = 120 degrees) for every one revolution of Maincrankshaft. Such Rotary Engine will be provided by ignition means of sparkplug type **(35)**, intake and outlet passage ports **(30)**, which is controlled by each valve **(31)** and provided with suitable valve spring **(32)** which is driven by rocker arms **(33)** which is controlled by the camshaft **(36)** between which the said both Rotor will be provideda central part of Housing **(39)** for positioning the above components properly as well as for the lubricating oil bed if so required.

Figure 4 & 5, are cross sectional and perspective view of the Type Two Rotary Engine, with **arcaded outer surface of Rotor (120)** which is fitted into the **arcaded cavity of the outer component or the Housing (segment I to segment VI)** which Rotor will rotate therearound in the planetary motion, and such motion or rotation if provided with proper speed ratio **(1rotation of the Rotor to 3 revolution of the Maincrankshaft),** therefore all centerlines or its extention lines/continuationline **(all a, b, c, lines)** will repeat to the same positions **(a1, a2, a3, a4, b1, b2, b3 b4, c, c2, c3, c4)** and maintain the same distance to the Maincrankshaft centerpoint axis **(point O),** and which such proper speed ratio is made posible by integrating the Rotor and Maincrankshaft rotations through the intermeshing gears train **(148, 152; 151, 147; 138 and 137 gears)** having its own separate hubshaft **(142)**which center axis is spaced apart and parallel to the Maincrankshaft **(124).** The Rotor is also provided with sealing elements **(126,127,128)** hollow shaft to fit with the eccentric hubshaft **123),**

Figure 6, is a **bi-lobed of epitrochoid form Housing** for tri-arched apex portion Rotor, which in fact can be divided into 6 segments to have its own each centerpoints, as can be seen clearly in the drawing.

Figure 7, is a **6-lobed outer surface of tri-arched apex portion of Rotor** which in fact can be divided into 6 segments to have its own each centerpoints, as can be seen from the drawing.

Figure 8 to 15 are showing the various positions of the 6 lobed 3 apex Rotor in relationships to each of its relative rotations. By such special design of outer surface Rotor therefore the outer surface of the Rotor and the inner surface of the Housing will match each other accordingly. In this drawings the Rotor is provided with channel for the purpose of obtaining the effective compression ratio.

Figure 16, is showing the various positions of the Rotor during its relative rotation all in one revolution of Rotor and 3 revolution of Maincrankshaft.

Figure 17, is the basic **bi-lobed Rotor with epicyclic Housing form** and two passage ports for intake and outlet purposes.

Figure 18, is the combination of the actual positions of the Rotor and its relevant eccentric hubshaft of Type One Rotary Engine consisted of two units bi-apex Rotor. This different positions will effect to the Housing positions each other as well as to the firing order of such engine.

Figure 19, is showing the complete rotations of Type One Rotary Engine in relations to its eccentric shaft positions.

Figure 20, is cross sectional view of the special cutting device for making the Type One Rotary Engine's Housing Form accurately. In such a device, the Mainframe **(257)** is supported by other means which is not shown in this drawing, to have the Maincrankshaft **(224)** and driving pulley in the middle of the frame **(253)** fixed or secured to the Maincrank shaft by means of inserted key **(256),** and such Maincrankshaft is hold by ball bearing to the frame **(244)**and fastened properly for free wheeling by fixing a closing bolt at the end of the shaft. Similar to the other Type One Rotary Engine, the Maincrankshaft is integrated its rotation to the Rotor by intermeshing gears train **(248/252, 251/247, 238/237)** to the gearing ratio as previously mentioned, which the first cluster gear assembly **(238 & 247)** to have also a hollows shaft provi ded with suitable needle bearing **(241)** at both ends for free wheeling purposes, and that the second cluster gears assembly **(251 & 252)** to have only one shaft **(242)** and which the cutting blade **(254)** is fixed and secured properly to the Rotor's centerline part **(221)** and fastened by menas of suitable bolt and nuts **(255),**and such Rotor is rotated therearound the eccentric hubshaft **(223)** secured by sleeve bearing **(222)** in between.

Figure 21 & 22, is cross sectional view of the epicyclic system used for Type One Rotary Engine as well as for Type Two Rotary Engine. Similar to the previously mentioned of Type One Rotary Engine, the epicyclic system is provided with planetary gears system comprises of one outer ring gear **(359)** which will be fixed or mounted within the outer part of the Housing, and within which outer ring gear will be intermeshed 3 units of arm gears **(362)** mounted to each own shaft for free wheeling **(361)** which shaft is fixed and secured to the arm **(360),** which the three arms gears are all intermeshed to the final pinion gear **(348)** which is mounted to the Maincrankshaft by gear mesh to have coaxial axis with the Maincrankshaft axis, and fastened by special nut **(349).** For Type Two the arm cluster gear consisted of **362/I** and **362/II** having one hollowshaft.

Figure 23, is cross sectional view of bi-apex Rotor **(421)** & Housing **(420)**provided Pinion gear **(438),** ring gear **(437)to gearing ratio of 2 : 3.**

Figure 24 & 25, are front view of tapered Rotor for compression space purposes and cross sectional view of the Rotor.

Figure 26 to 34, are showing each detail of the rotational position of the bi-apex Rotor within one revolution of the Maincrankshaft.

Claims

1. A Rotary Internal Combustion Engine in which the outer component is consisted of a stationary embodiment of epicyclic form having an arcaded inner periphery Housing wall that defines an arcaded internal cavity, within which cavity is mounted the inner component of rotating embodiment or the Rotor, movable therearound in a planetary motions, having arched bi-apex portions with arcaded outer peripheral surfaces.

2. A Rotary Internal Combustion Engine in which the outer component is consisted of a stationary embodiment of bi-lobed epitrochoidal form having an arcaded inner periphery Housing wall that defines an arcaded internal cavity, within which cavity is mounted the inner component of rotating embodiment or the Rotor, movable therearound in a planetary motion, having arched tri-apex portions with arcaded outer peripheral surfaces.

3. Rotary Internal Combustion Engines as claimed in claim 1 & 2, which each unit of the said engine will comprise of 2 (two) units of stationary arcaded outer embodiments or arcaded Housings and 2 (two) units of arcaded outer surface Rotors, and 1 (one) unit of the driveshaft train member, consisted of 1 (one) unit Maincrankshaft with 2 (two) units integral eccentric hubshafts, 2 (two) units of intermeshing gear trains, which each unit of the intermeshing gear train will consisted of 1 (one) unit Internal Involute Gear fixed to one side of the Rotor and 2 (two) units of cluster gears assembly and 1 (one) unit of final Pinion gear mounted to the Maincrankshaft by gearmeshing to have coaxial centerline axis with the Maincrankshaft axis.

4. Rotary Internal Combustion Engines as claimed in the claim 3, in which operational rotations will be based on OEI BASIC PRINCIPLE of Rotary Engine as follows :

"Every apex portions of each centerline or its continuation of either bi-apex or tri-apex Rotor, during all its relative rotations, will repeat to the same positions and maintain the same distance to each of their Maincrankshaft axis centerpoint, provided such Rotor certerlines are rotating therearound an eccentrical circle having basic eccentric ratio of 1 : 2 for bi-apex Rotor and 2 : 3 for tri-apex Rotor, and to the speed ratio of one rotation of the bi-apex Rotor centerline to two revolutions of the Maincrankshaft, or one rotation of the tri-apex Rotor centerline to three revolutions of the Maincrankshaft, and that the rotations of the Rotor and the Maincrankshaft are to the same directions".

5. Rotary Internal Combustion Engines as claimed in the claim 4 in which arched bi-apex or tri-apex Rotor is made and constructed in 180 (one hundred and eighty) degrees angular form provided with suitable grooves for sealing rings/elementswhich form will not create any corner leakage possibility.

6. Rotary Internal Combustion Engines as claimed in claim 5, that in order to obtain the effective compression ratio for the engines, the both cooperating arcaded shapes between the arcaded outer surface of the Rotor and the arcaded inner surfaces of the Housing wall to have sufficient space in between by constructing or machining the outer surface of the Rotor in such a way that the arcaded shapes between the two adjacent arched apex portion of the said Rotor will be relatively decreased from 180 degrees arched formshape at each apex portions to become minimum in the middle depended to what extent of the compression ratio will be determined.

7. Rotary Internal Combustion Engines as claimed in the claim 6, that within each arcaded internal surface of the Housing wall will have 2 (two) kind of relative rotational shapes depended from which axis centers it is measured, such as :

The First Shape, as it is measured from the axis center of the Maincrankshaft, from which this First Shape has only arched 180 degrees shape at the positions where the centerlines of the Rotor meet or over-lined the vertical and horizontal corrsing lines through the axis center of the Maincrnakshaft, thereafter between the said two adjacent 180 degrees shapes, the arcaded shape of the inner surface Housing wall will be decreased to minimum in the middle depended to each typical arcaded form of the outer components.

The second shape, as it can be measured from the relative positions of the rotating center-point of the Rotor centerlines, which rotates therearound its basic eccentric circle of each type Rotary Engine, from which rotating -points, the second shape has always arched 180 degrees shape during its relative rotations, provided that the Rotor maintains its speed ratio accordingly.

8. Rotary Internal Combustion Engines as claimed in the claim 7, which specific form of the arcaded inner surfaces of the Housing wall is made and constructed by using a special cutting device/equipment which has the same construction as the claimed Rotor including the intermeshing gear trains thereon, but provided with proper cutting blades secured and fastened to the central part of the Rotor, so therefore it will be able to cut and form the arcaded inner Housing wall form exactly to the same form of the Rotor Rotation Form including the effective clearance as it may required .

9. Rotary Internal Combustion Engines as claimed in the claim 8 in which within the outer component will be provided with intake and outlet passage port means for communicating the concern working chambers, either with or without valves, for alternatingly feeding sufficient air or the mixture of fuel air into its proper variable volume working chambers that are defined during its relative rotations between the both cooperating shapes of the inner and outer components and flow it out after the stage of ignition and combustions has been concluded properly.

10. Rotary Internal Combustion Engine, as claimed in claim 9 and which ignitions means will be either sparkplug type or fuel injection type such as Rotary Diesel Engine using diesel fuel only.

11. Rotary Internal Combustion Engines as claimed in claim 10 and which outer component in order to be able inserted by the inner component, therefore such outer component will be made and constructed into 2 or more separate parts, either through the centerline of transverse plane cut or through the middle circumferential line of the outer components.

12. Rotary Internal Combustion Engines as claimed in the claim 11 in which each arched apex portion of the Rotor will be constructed suitable grooves for the sealing rings installation seat and that such inner housing wall will be chrome plated for obtaining the smooth and hard surfaces which has a good affinity for the lubricating oil and to reduce the wearing rate significantly.

13. Rotary Internal Combustion Engine, as claimed in the claim 12 and which the arched tri-apex Rotor beside to have 3 arcaded outer sur face will have an alternative design of 6 (six) arcaded outer surfaces but still maintain said 3 (three) arched apex portion Rotor, which said 6 (six) arcaded outer surface Rotor form will match properly to the inner surface of the Housing between the compression cham ber part and its opposite similar section, and therefore such construction will able to prevent the interfere of the exhaust gases into the adjacent intake chamber accordingly.

14. Rotary Internal Combustion Engines as claimed in the claim 13 in which arched bi-apex Rotor's rotation will be integrated to the Maincrankshaft rotation by constructing intermeshing gear train in between, and to the fix gearing ratio of 2 : 3 for first pinion gear of the first cluster gear assembly to the ring gear of the Rotor, and gearing ratio of 1:2 for the first gear of the second cluster gear assembly to the second gear of the first cluster gears assembly and ratio of 1 : 2 for the final Pinion gear which is mounted or fixed and to have coaxial centerline axis with the centerline axis of the Maincrankshaft, to the second gear of the second cluster gears assembly.

15. Rotary Internal Combustion Engines as claimed in the claim 13 in which arched tri-apex Rotor's rotation will be integrated to the Maincrankshaft rotation by constructing intermeshing gear train in between, and to the fix gearing ratio of 3 : 4 for the first Pinion gear of the first cluster gears assembly to the ring gear of the Rotor, and gearing ratio of 1 : 3 for the first gear of the second cluster gears assembly and gearing ratio of 1 . 3 for the final Pinion gear which is mounted or fixed and to have coaxial centerline axis with the centerline axis of the Maincrankshaft, to the second gear of the second cluster gears assembly.

16. Rotary Internal Combustion Engines, as claimed in the claim 14 and 15, that in order to obtain different alternative variation of the gearing ratio of the intermeshing gear train, therefore RASER FORMULA will be applicable in formulating the gearing composition as follows:

I.I.G.P./I.I.G. - a/b = 1/2 for bi-apex Rotor and

I.I.G.P./I.I.G. - a/b = 2/3 for tri-apex Rotor and

a/b = I.I.G.P./I.I.G. x c/d x e/f

whereas :

I.I.G.P. refers to the pitch diameter of the Internal Involute Gear Pinion

I.I.G. refers to the pitch diameter of the Internal Involute Gear.

a/b refers to the rotational speed factor of the ring gear or I.I.G. to be increased or decreased within every one revolution of the Maincrankshaft.

c/d refers to the gearing ratio of the second gear of the first cluster gears assembly to the first gear of the second cluster gears assembly.

e/f refers to the gearing ratio of the final Pinion gear which is fixed or mounted and to have a coaxial centerline axis with the centerline axis of the Maincrankshaft, to the second gear of the second cluster gear assembly.

1/2 refers to the basic eccentric ratio for the Rotary Engine having bi-apex Rotor and a single epicyclic form of Housing.

2/3 refers to the basic eccentric ratio for the Rotary Engine having tri-apex Rotor and bi-lobed epitrochoids Housing.

17. Rotary Internal Combustion Engine as claimed in the previous claims in which the Housing is of epicyclic form with bi-apex Rotor having its rotations timing punctually by means of **epicyclicgears train or planetary gears system,** in which **the inner ring gear or I.I.G.** of the Rotor is intermeshed to **Pinion gear which is made and constructed in one hollow shaft with the arm of the planetary gears system,** provided with suitable needle bearings, at its both end of hollow shaft. For the Rotary Engine with bi-apex Rotor and single epicyclic Housing, the said gearing ratio is fixed to 3 for I.I.G. and 2 for the I.I.G.P. Within the said planetary arm will be mounted **3 (three) arm gears** having each own fixed hubshaft and sleevebearings for free wheeling therearound, which arm-gears will be intermeshed to the **outer ring gear** which is secured to the outer part of the engine Housing to have gearing ratio fixed **3 : 1** for the Rotary Engine with bi-apex Rotor which means the outer ring gear is 3 (three) times larger than the said arm gear, and the said outer ring gear is also intermeshed to the final pinion gear which is mounted and to have a coaxial centerline axis with the centerline axis of the Maincrankshaft, based on gearing ratio of **1 : 1**-which means the final pitch diameter has the same pitch diameter of the said intermeshed arm-gears.

18. Rotary Internal Combustion Engine as claimed in the previous claims in which the Housing is of 2 lobed epitrochoid form with tri-apex Rotor having its rotations timing punctually by means of **epicyclic gears train or planetary gears system,** in which the inner ring gear or I.I.G. of the Rotor is intermeshed to Pinion gear **which is made and constructed in one hollow shaft with the arm of the planetary gears system,** provided with suitable needle bearings, at both ends of the shaft, and in which the **arm gears are constructed in 3 cluster gears assembly each of them to consist of 2(two) units of gears.** For the Rotary Engine with tri-apex Rotor and 2 lobed of epitrochoid Housing, the gearing ratio of the inner ring gear and the Pinion or the I.I.G.P.:I.I.G. is fixed to the ratio of **3 : 4 (three I.I.G.P. to four of the I.I.G.).**

Within the said planetary arm will be mounted the 3 cluster gears assembly having each own fixed hubshaft and suitable sleeve bearing for free wheeling therearound, which the first gear of the said arm cluster gear will be intermeshed to the**outer ring gear** which is fixed and secured to the outer part of the Housing, based on gearing ratio of **4 : 1,** which means that the outer ring gear to have pitch diameter of 4 (four) times larger than the first gear of the arm cluster gear assembly.

The second gear of the arm cluster gear assembly which is significantly larger than the first gear, is intermeshed to the final pinion gear which is fixed or mounted and to have its centerline coaxial with the centerline of the Maincrankshaft, based on the gearing ratio of **2 : 1** which means that the second gear of the arm cluster gear assembly has its pitch diameter **twice(two times)** as much of the pitch diameter of the final gear pinion.

19. Rotary Internal Combustion Engine, as claimed in the previous claims including all type of vehicles, equipments or apparatus provided with Rotary Engine, or Rotary Equipments/machines, special cutting device , rotary compressors, rotary pumps, or rotary system suitable for the aircraft engines, vessels, or any future flying crafts, using any kind of fuels, for either sea, land or air transportaions means as hereinbefore described with references to the accompanying drawings.

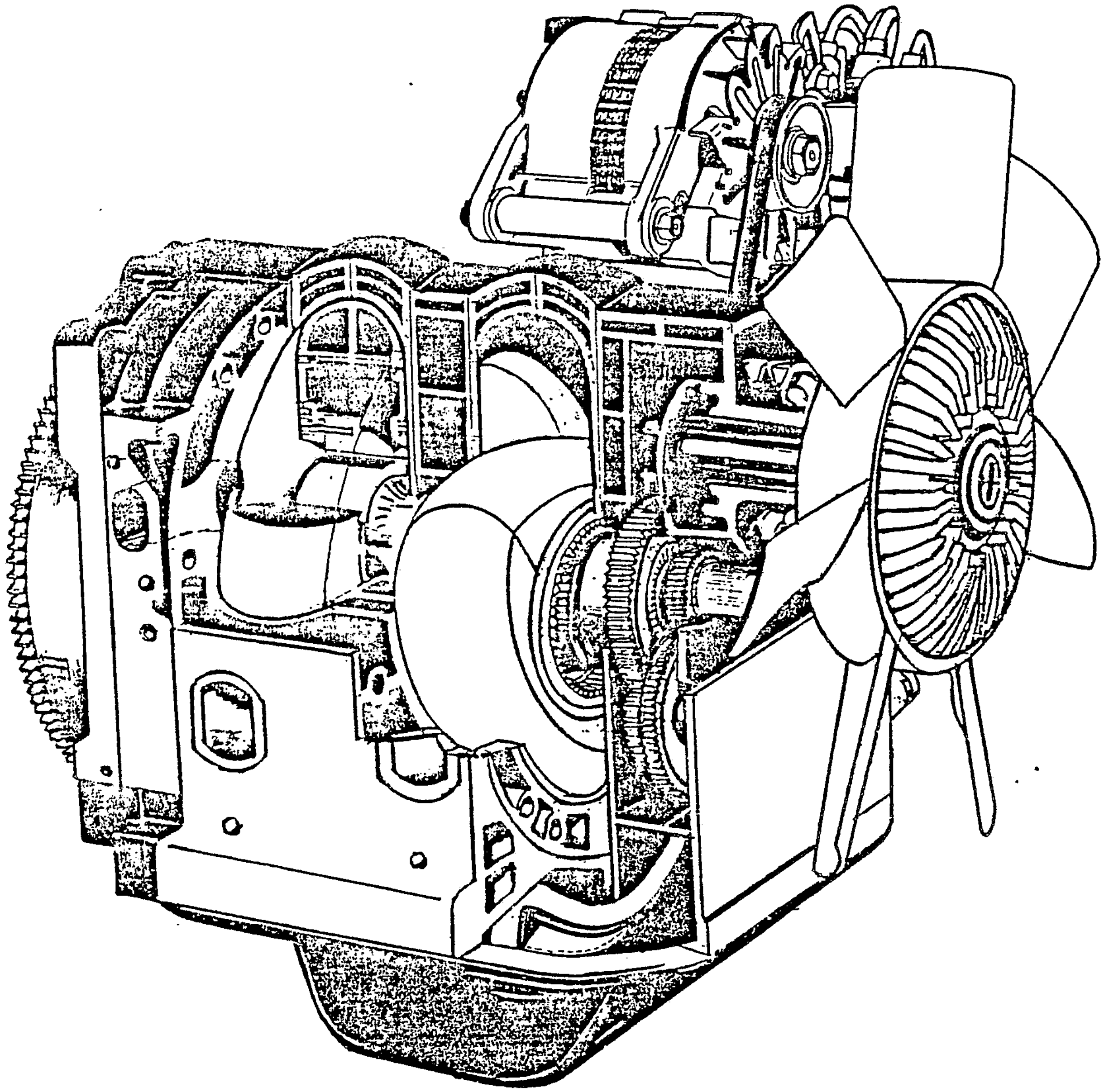


Fig. 1

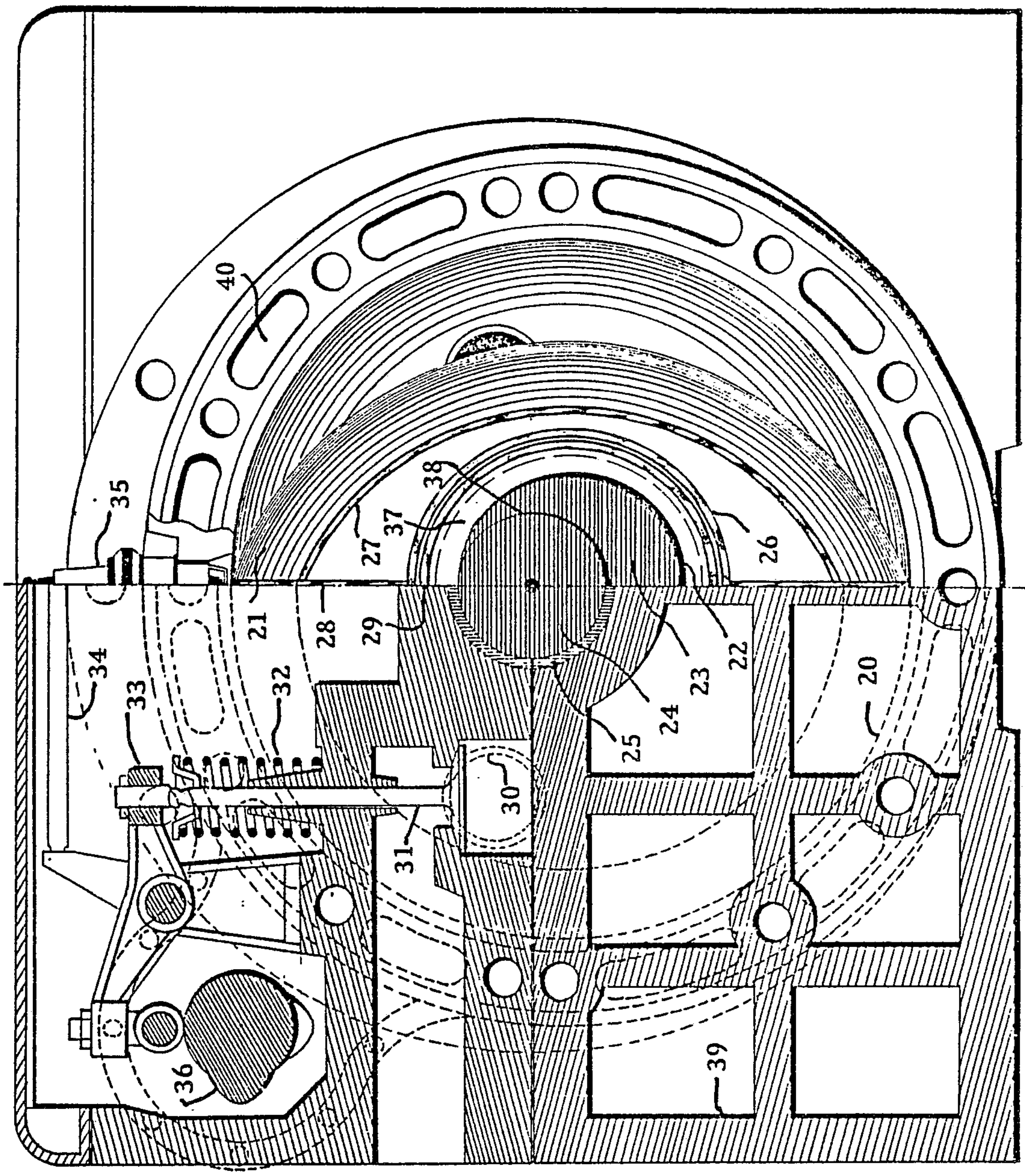
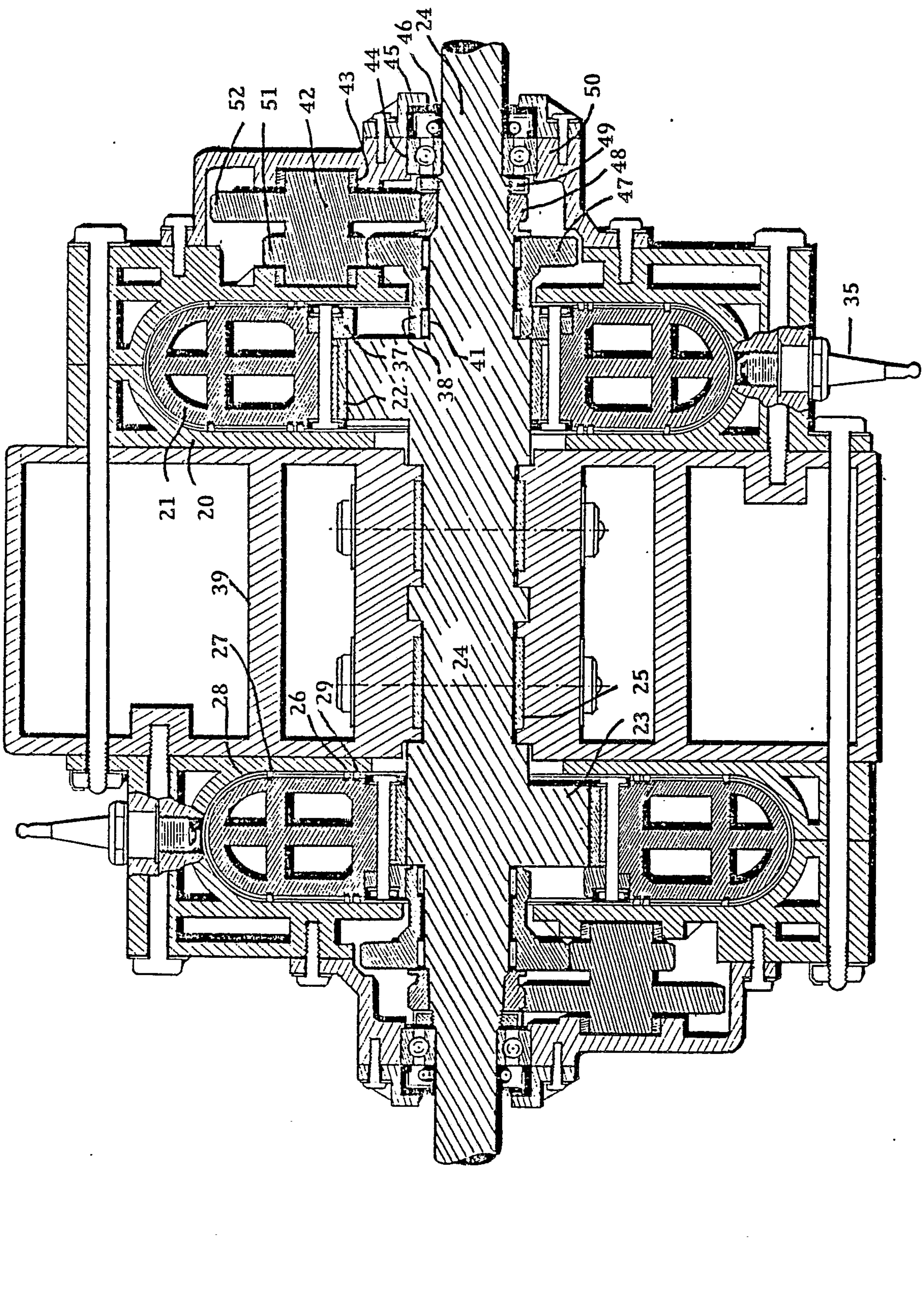


Fig. 2

Fig. 3


52
51
42
43
44
45
46
24
50
49
48
47
35
41
38
37
22
21
20
39
27
28
26
29
24
25
23

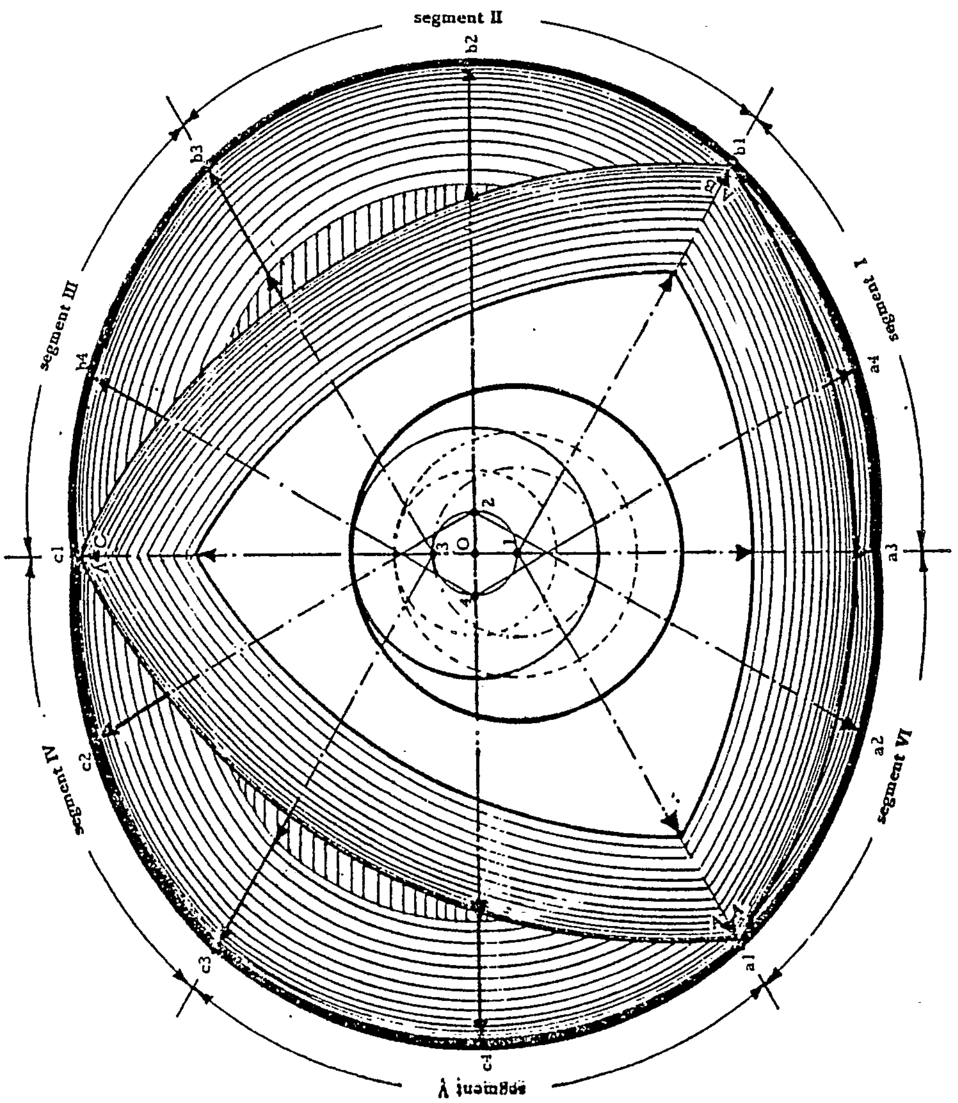

segment I
segment II
segment III
segment IV
segment V
segment VI
a1
a2
a3
a4
b1
b2
b3
b4
c1
c2
c3
c4
O
1
2
3
4

Fig. 4

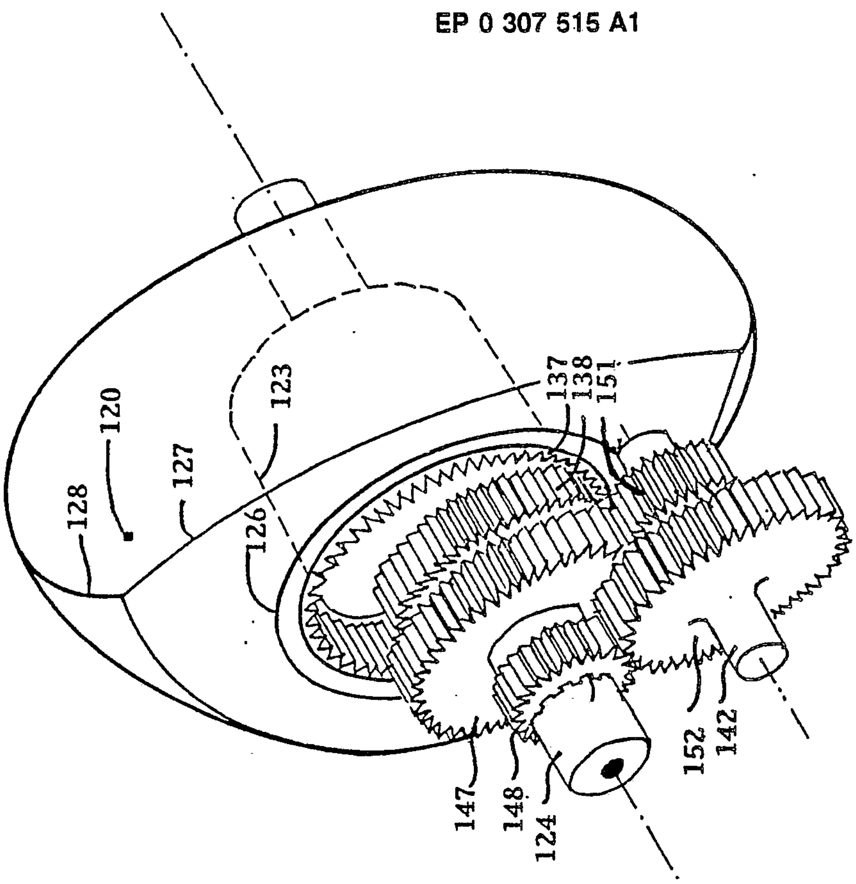

120
123
124
126
127
128
137
138
142
147
148
151
152

Fig. 5

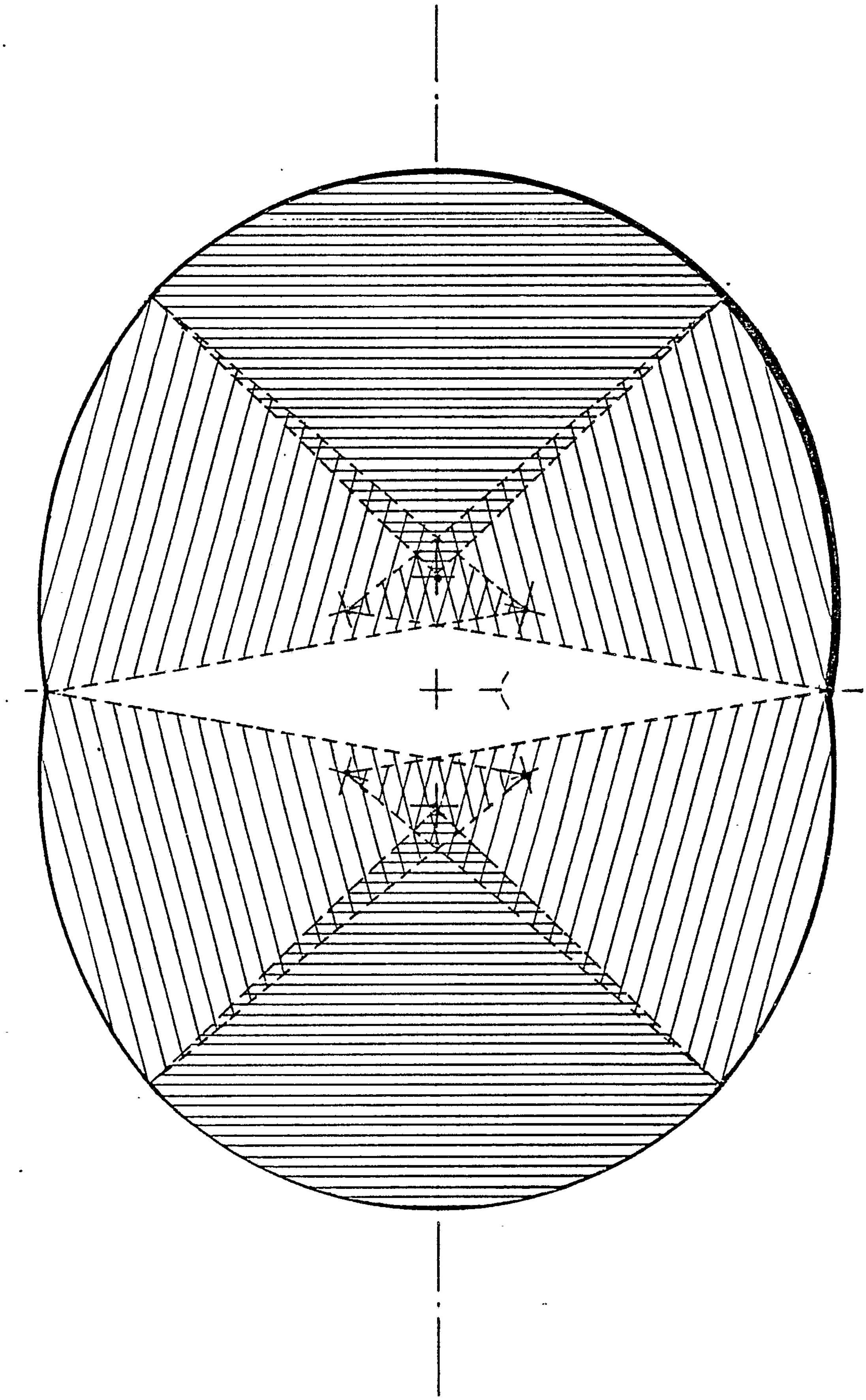


Fig. 6

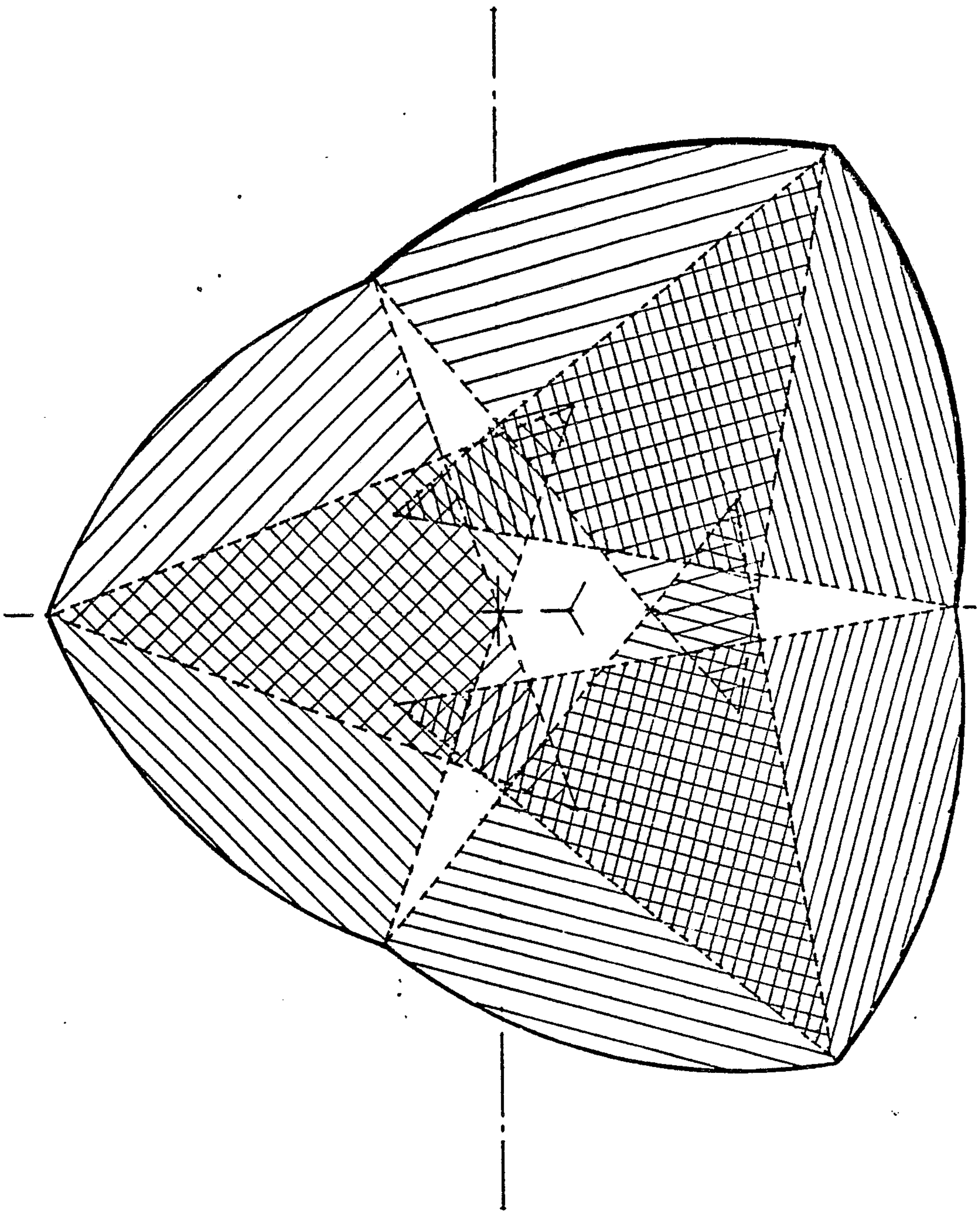


Fig. 7

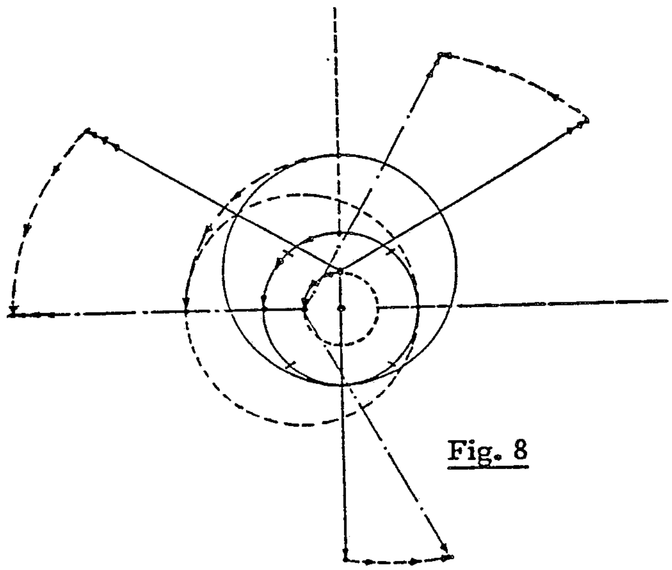


Fig. 8

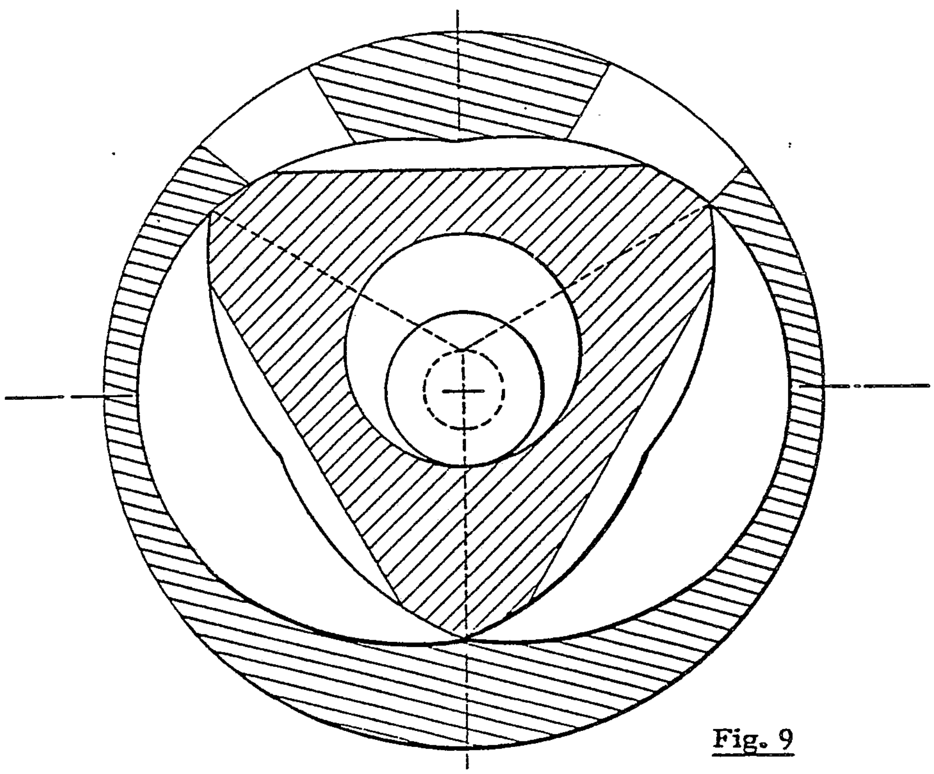


Fig. 9

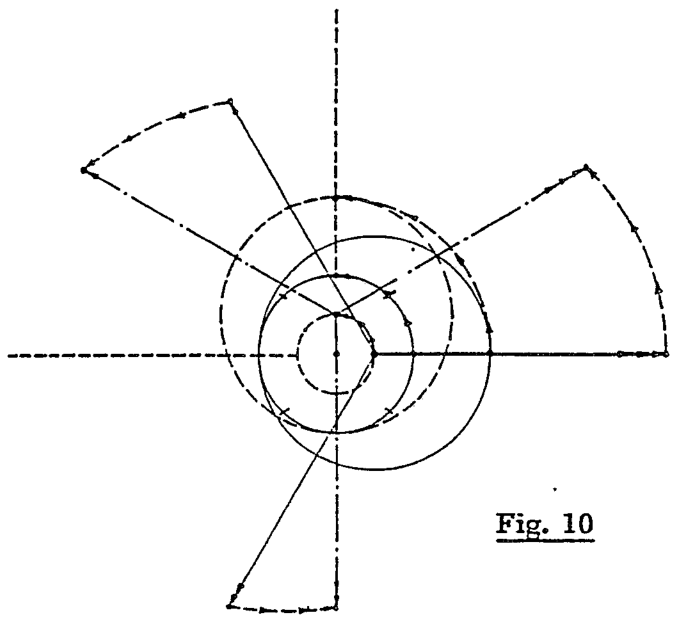


Fig. 10

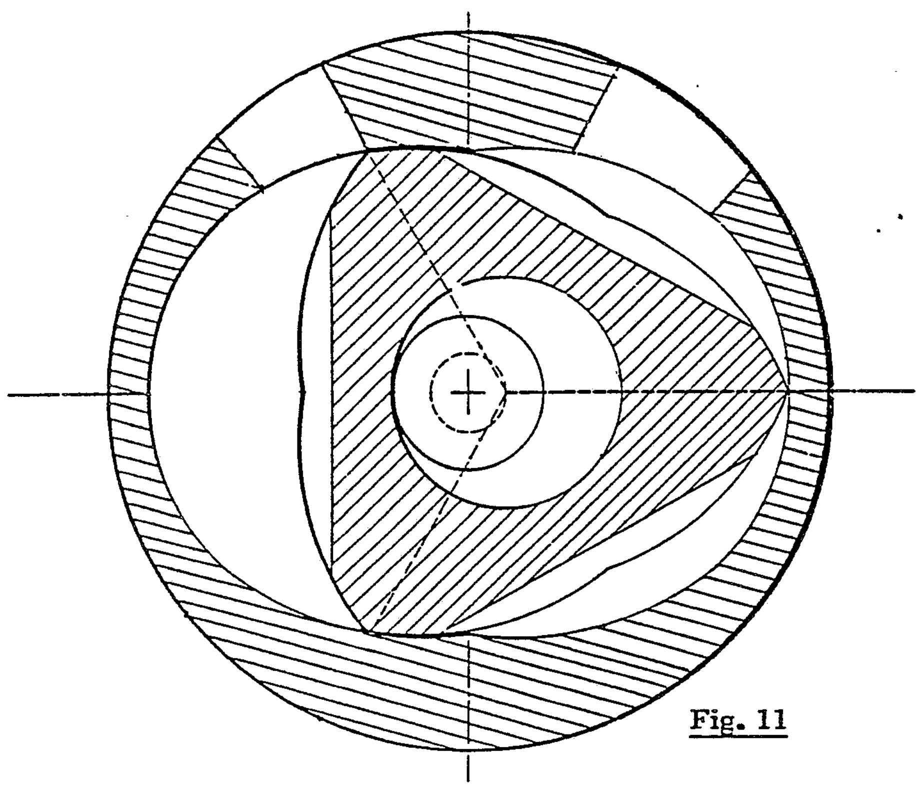


Fig. 11

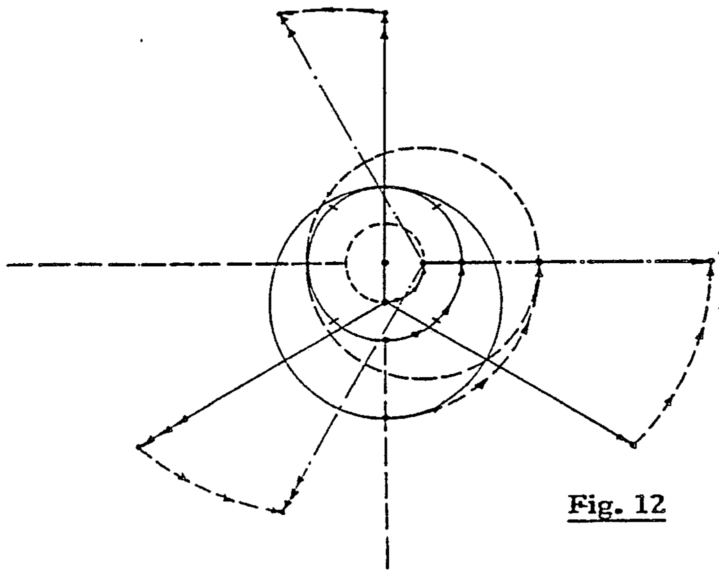


Fig. 12

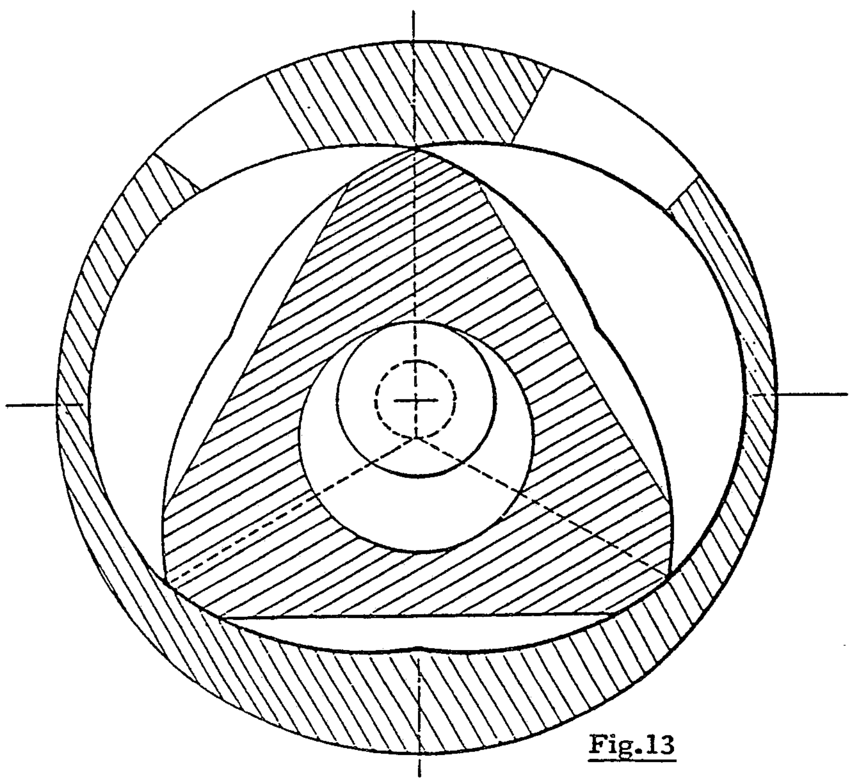


Fig.13

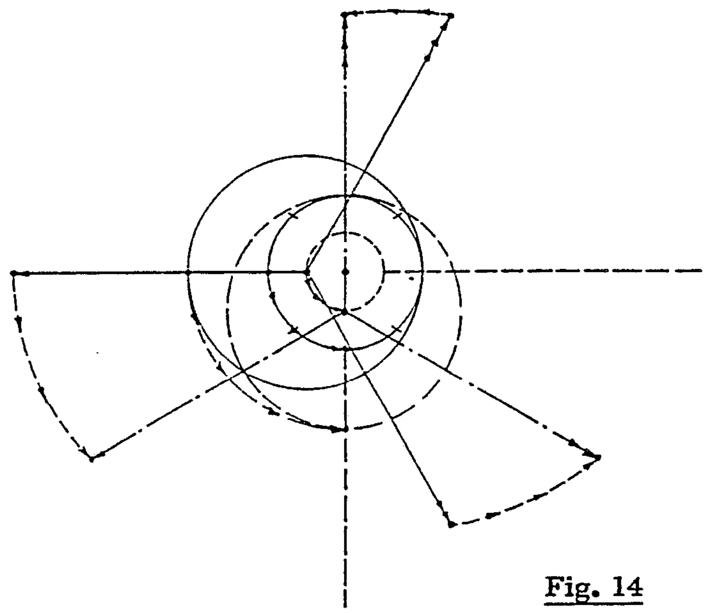


Fig. 14

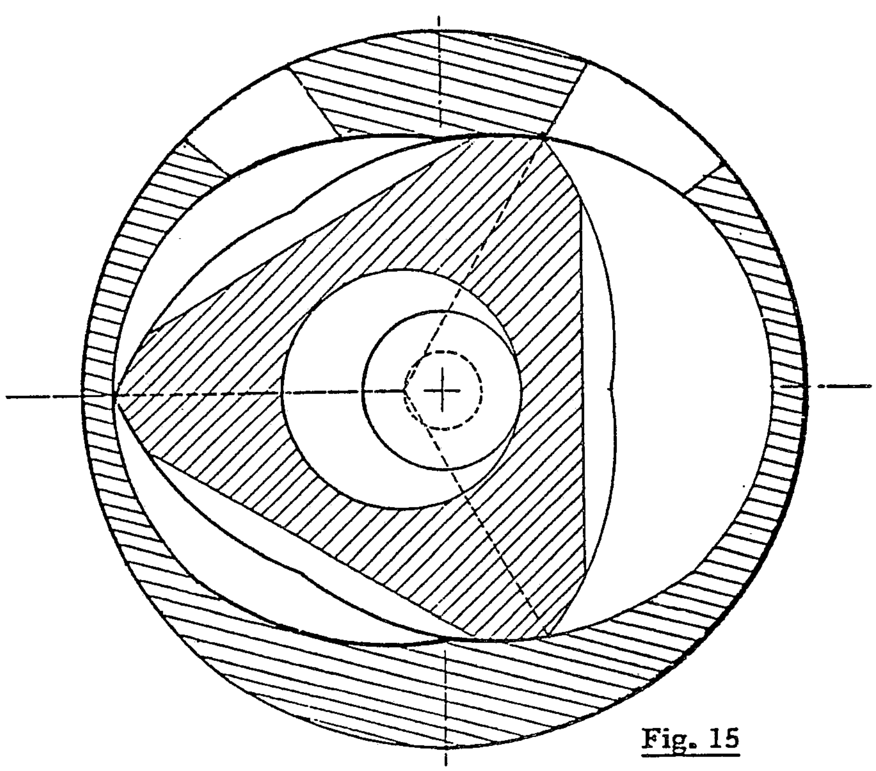


Fig. 15

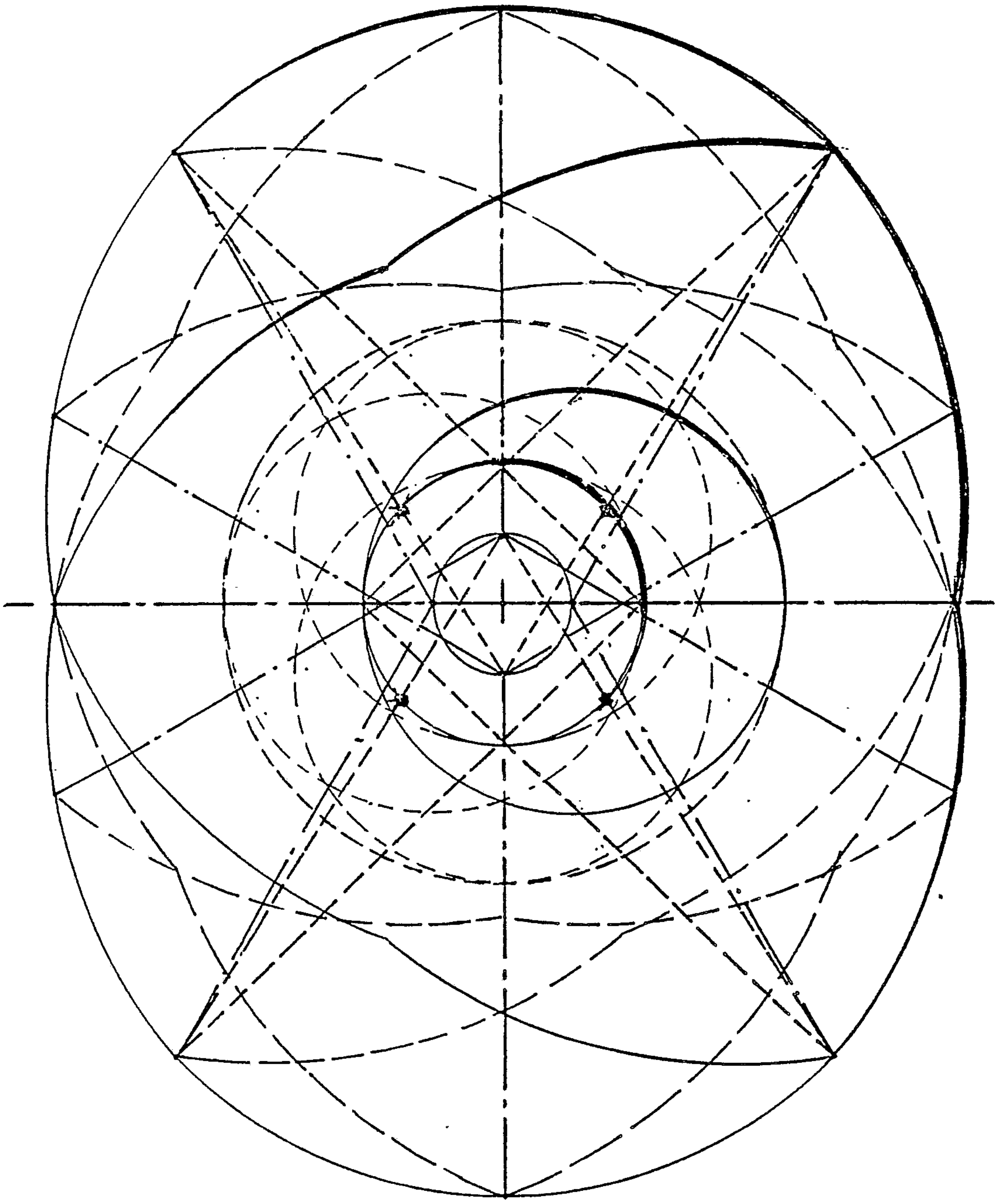


Fig. 16

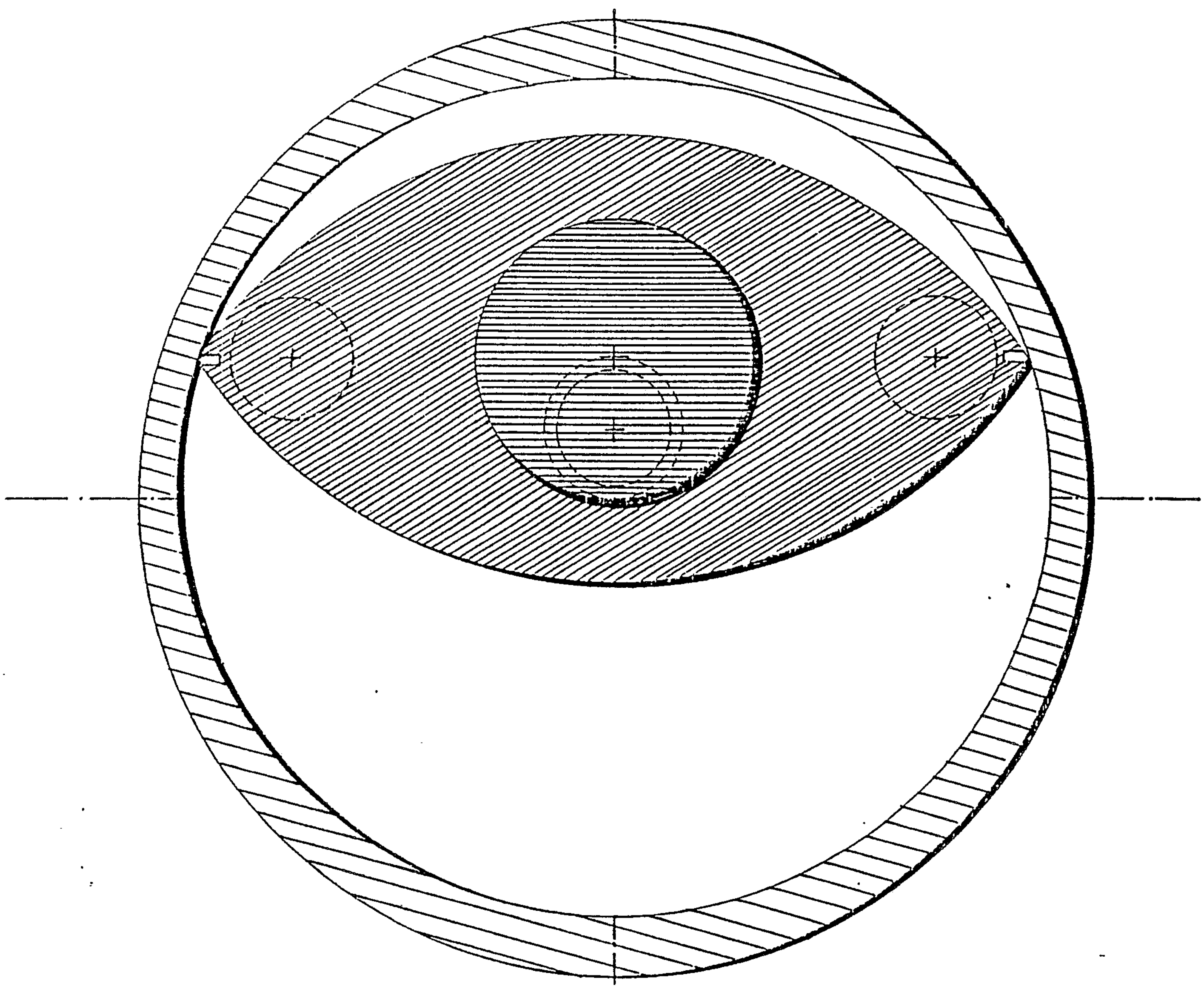


Fig. 17

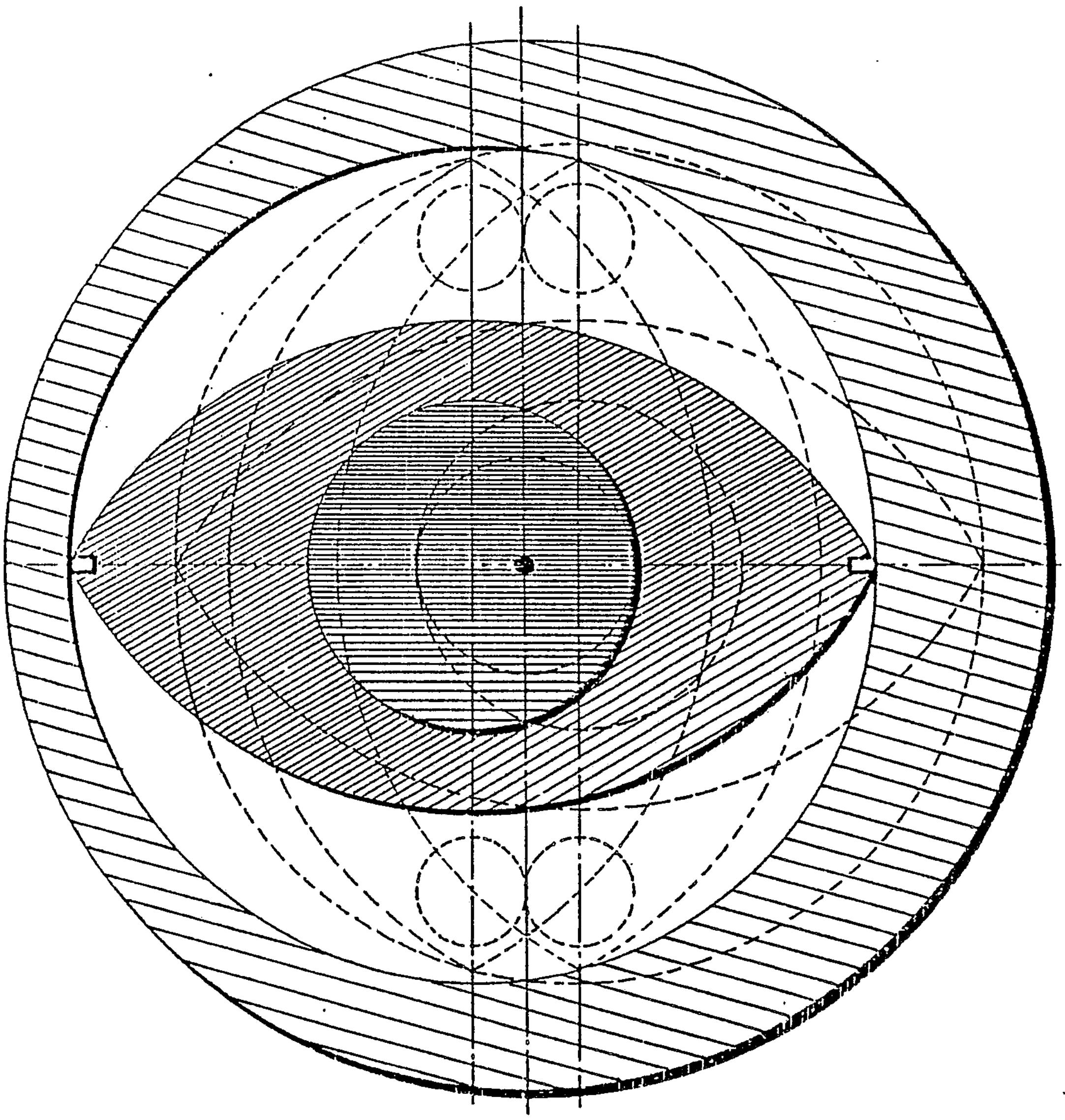


Fig. 18

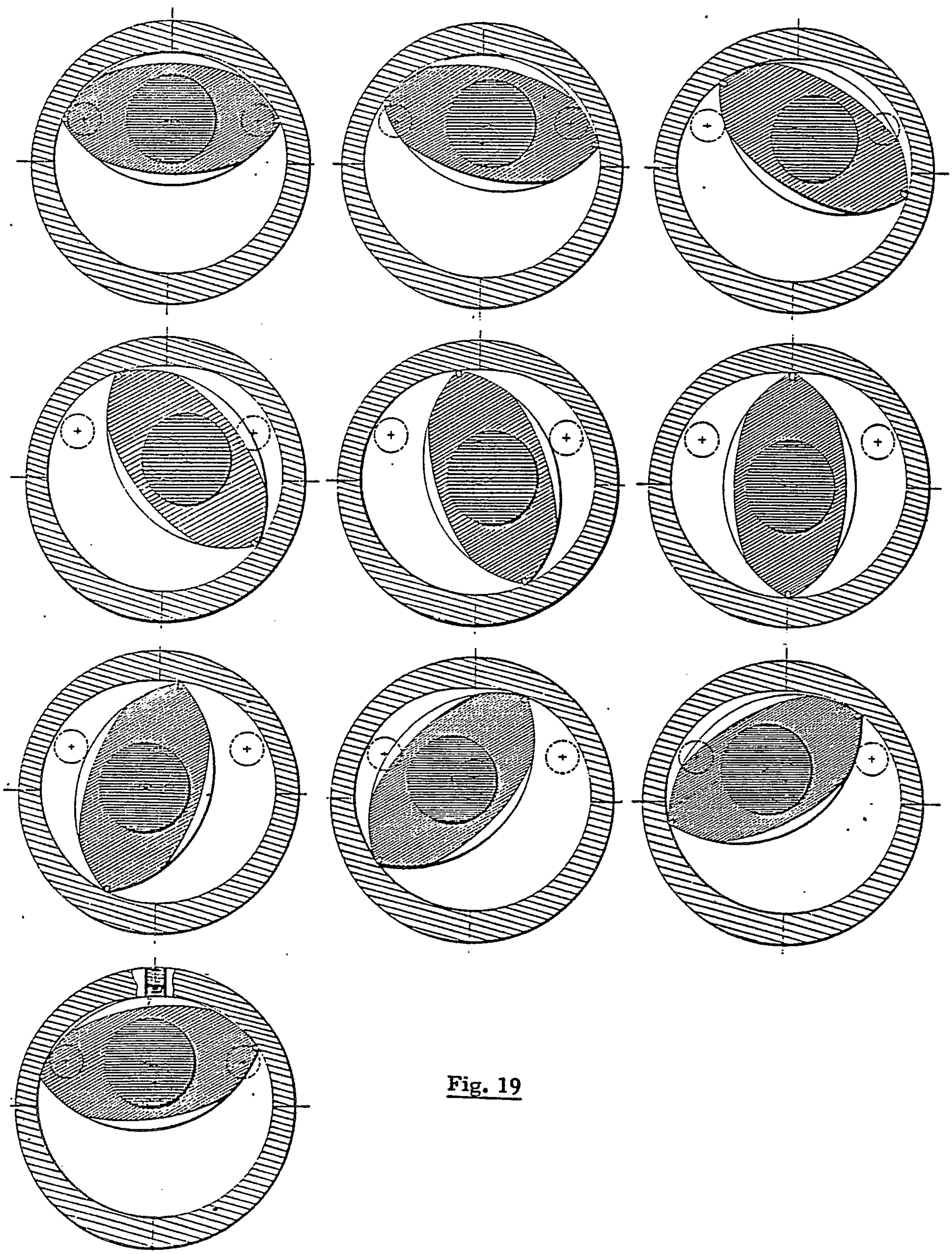
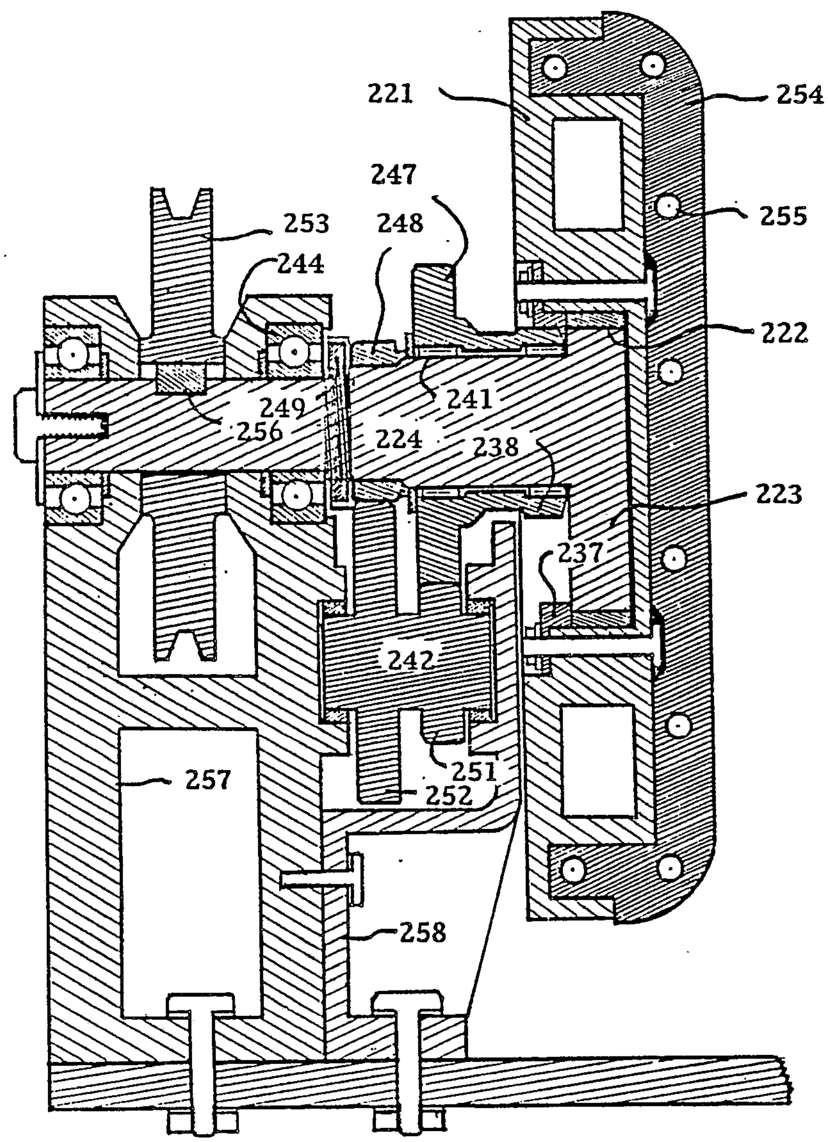


Fig. 19

Fig. 20


221
254
247
255
253
248
244
222
241
249
256
224
238
223
237
242
257
251
252
258

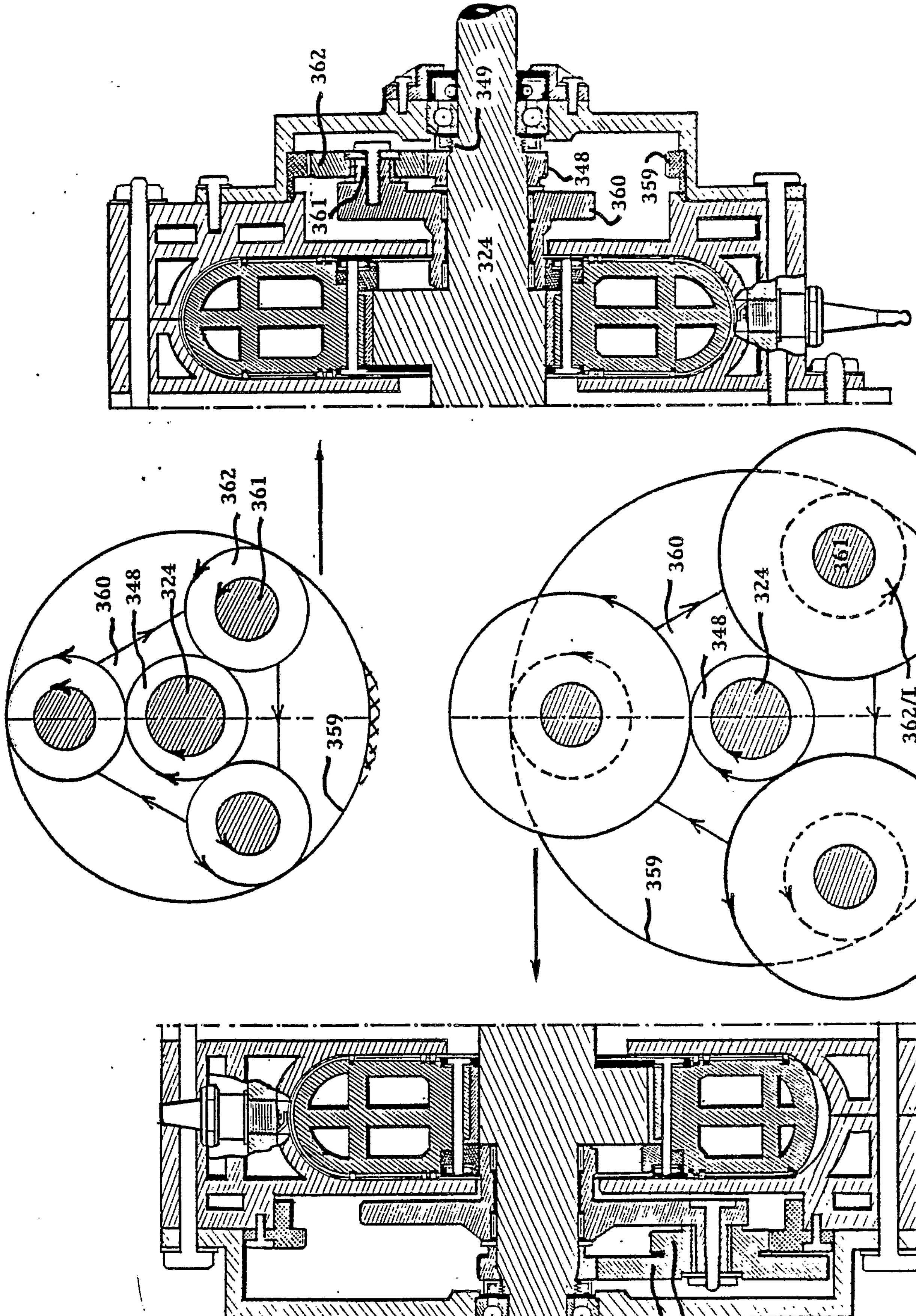

362
349
361
348
359
360
324
360
348
324
362
361
359
360
348
324
361
362/I
362/II
359
362/II
362/I

Fig. 22

Fig. 21

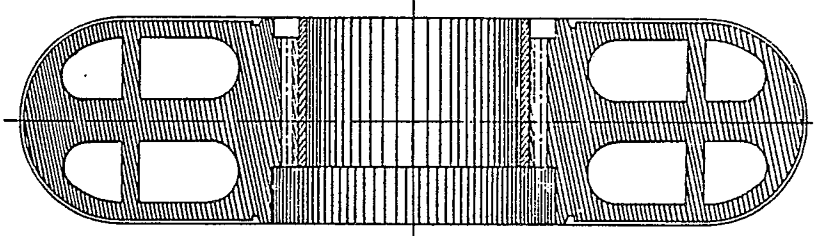


Fig. 25

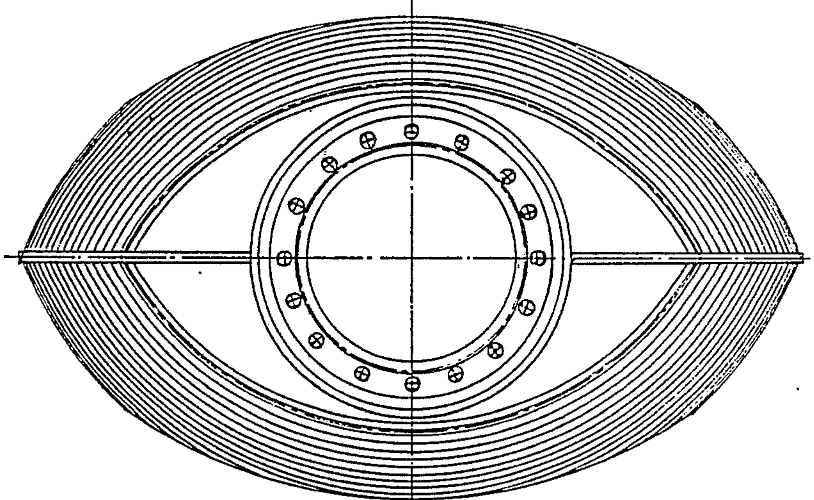


Fig. 24

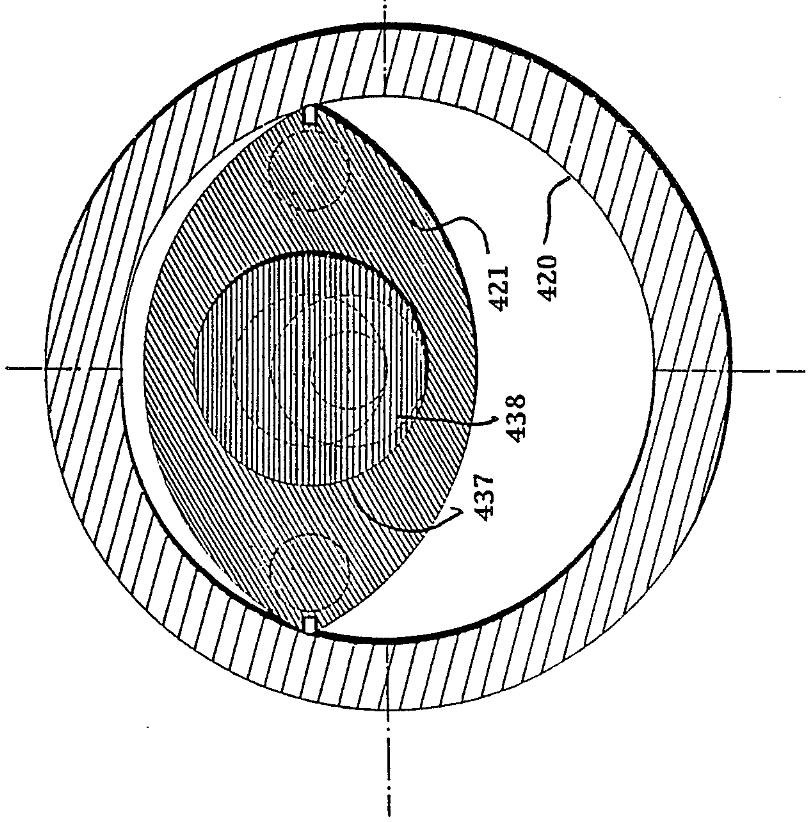


Fig. 23

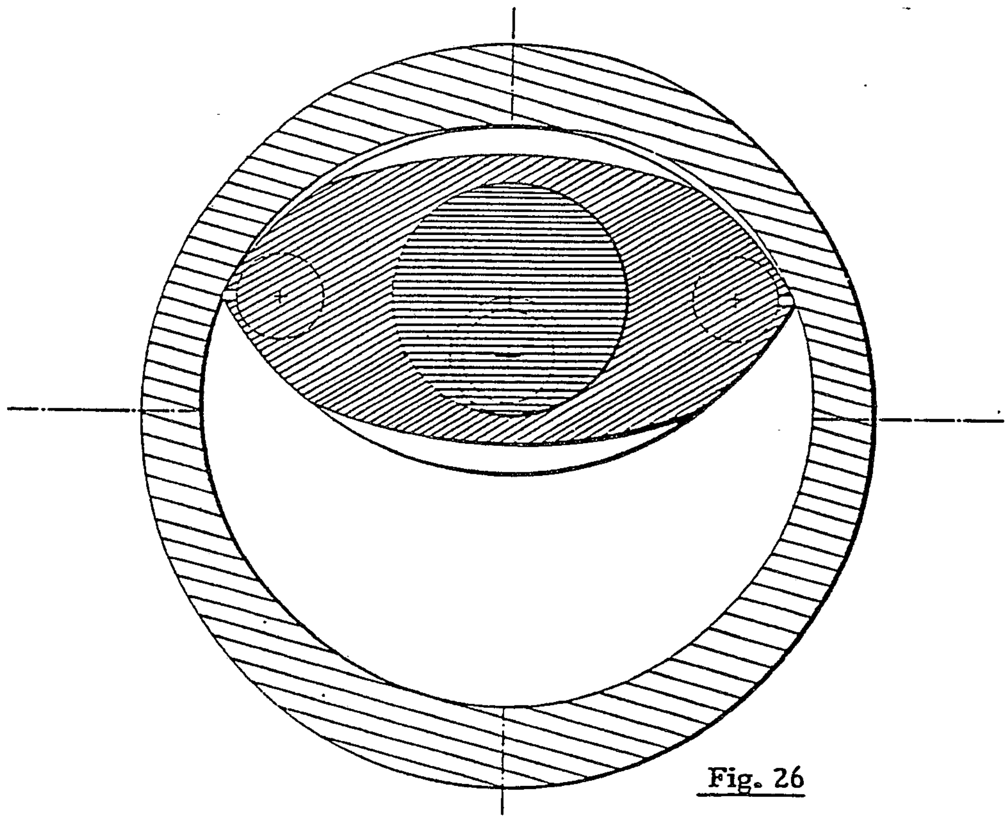


Fig. 26

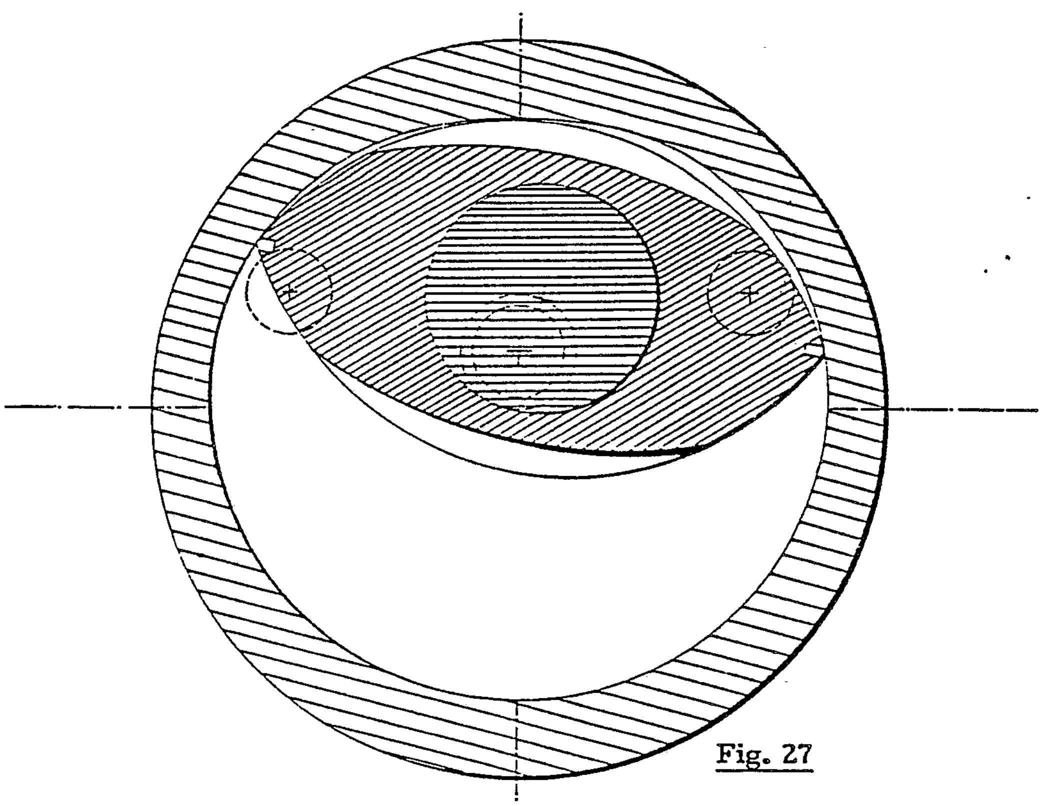


Fig. 27

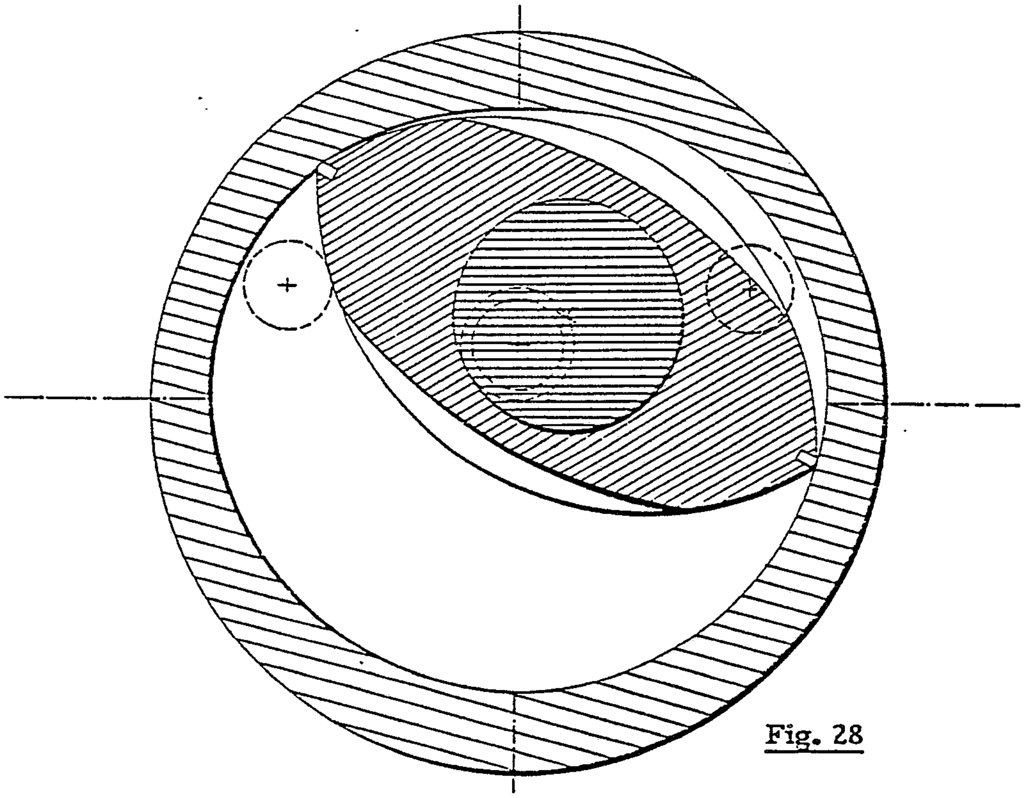


Fig. 28

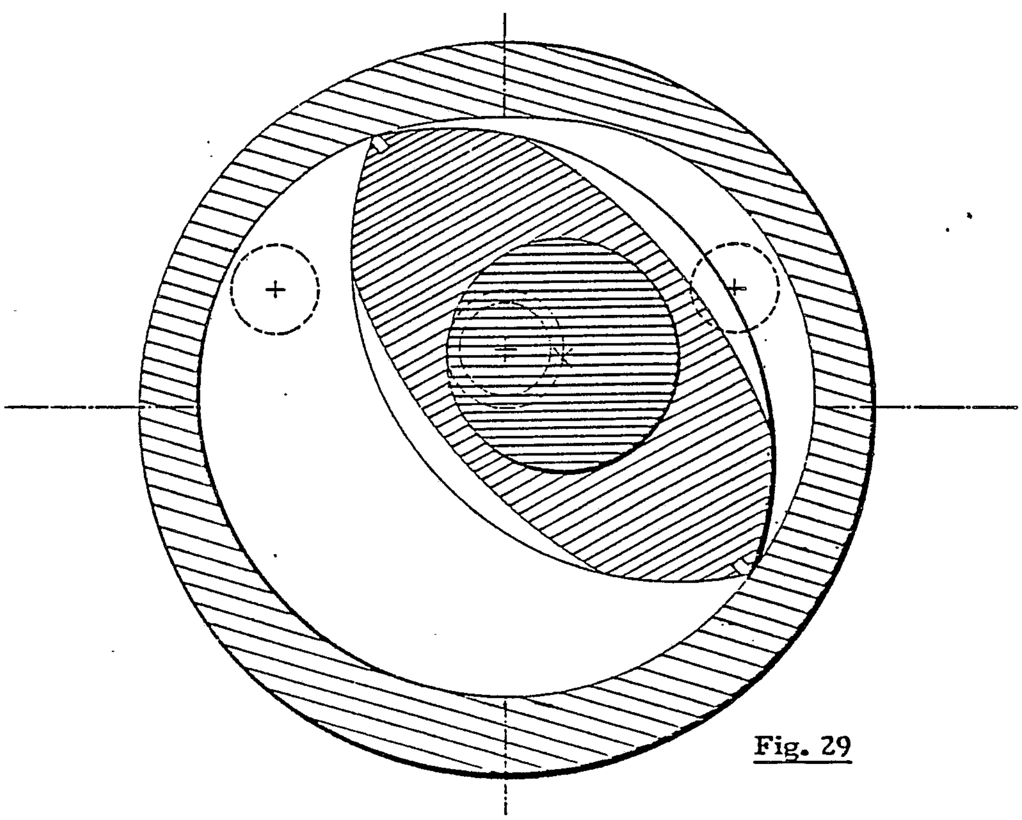


Fig. 29

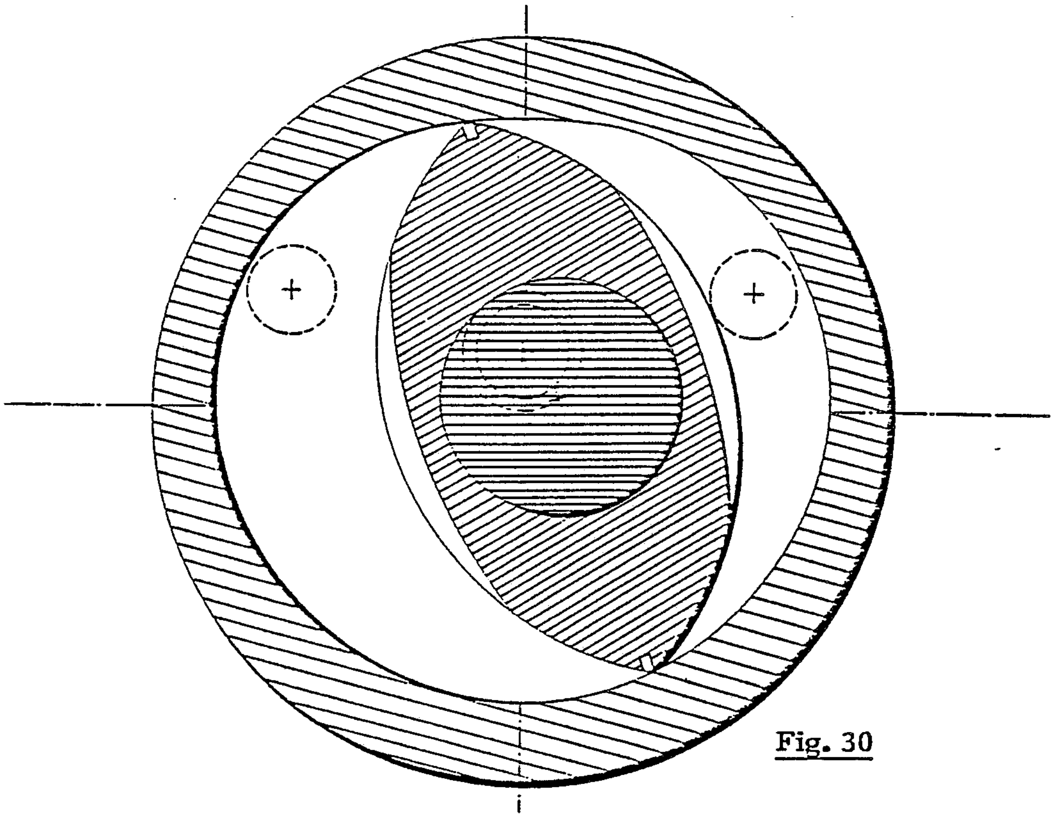


Fig. 30

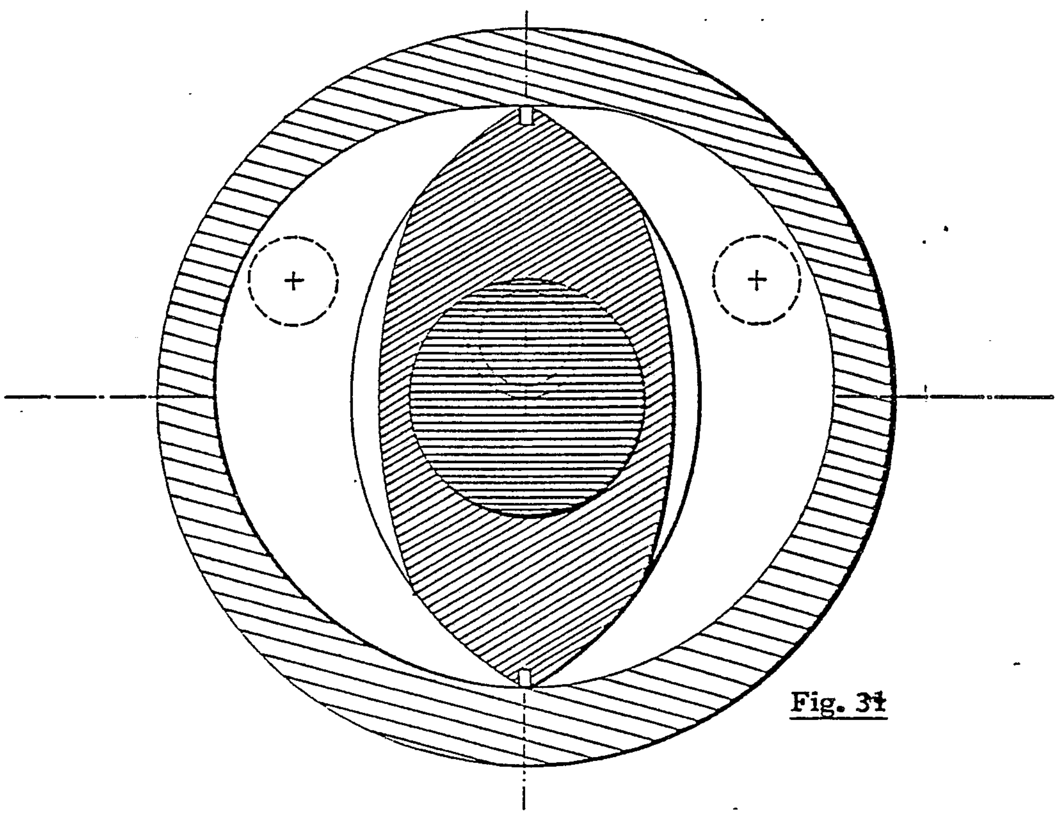


Fig. 31

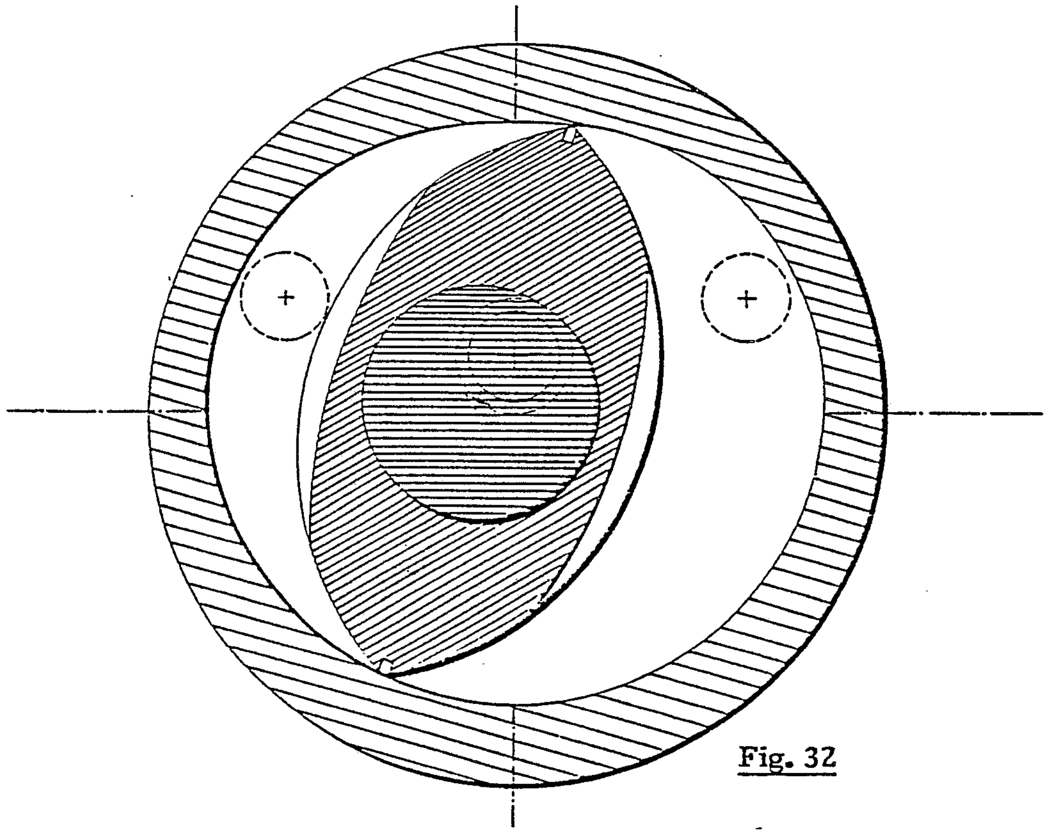


Fig. 32

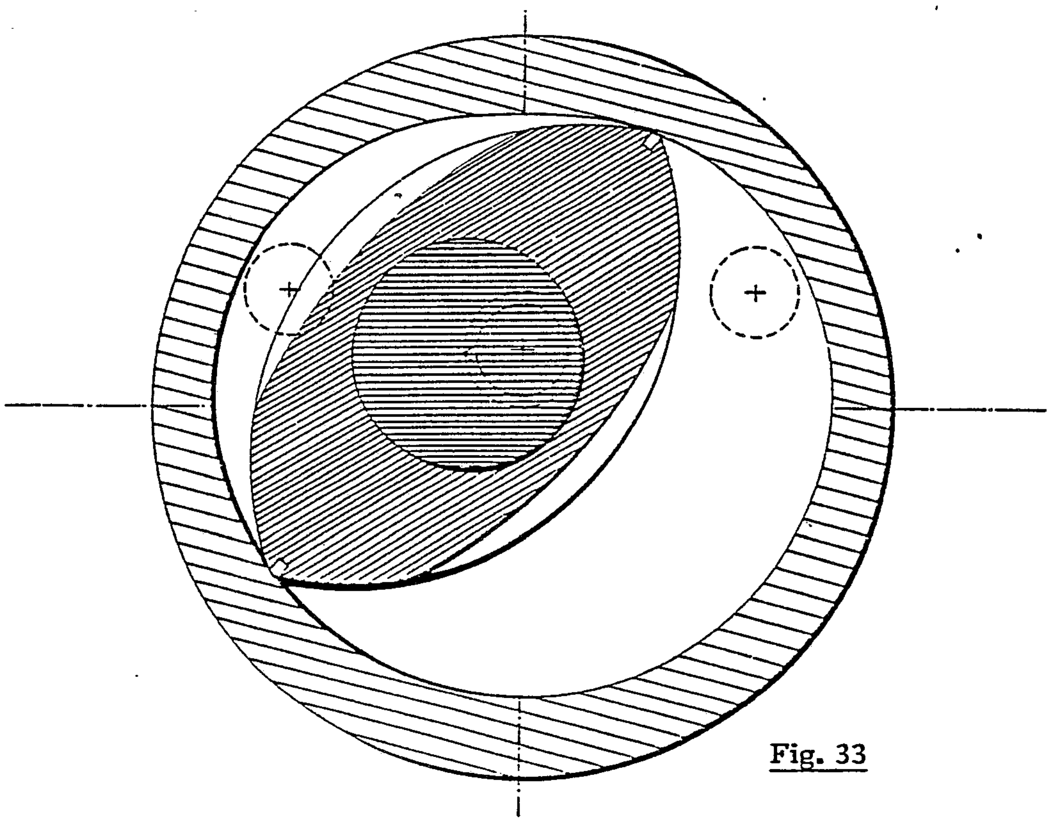


Fig. 33

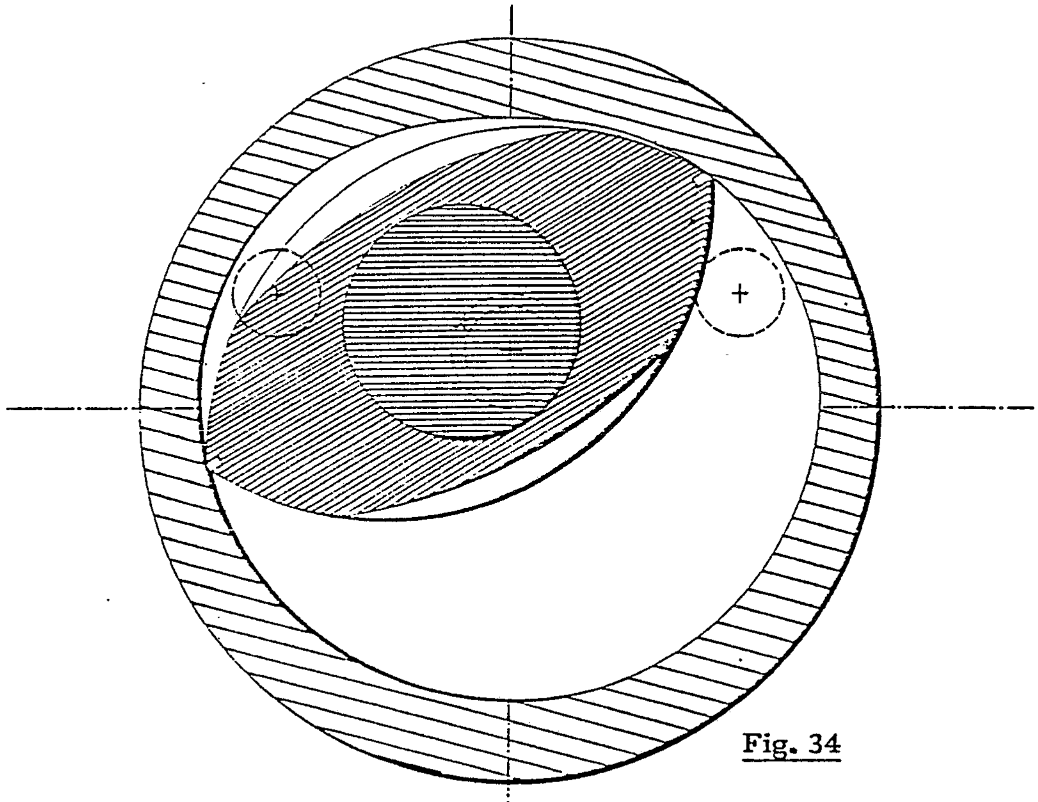


Fig. 34

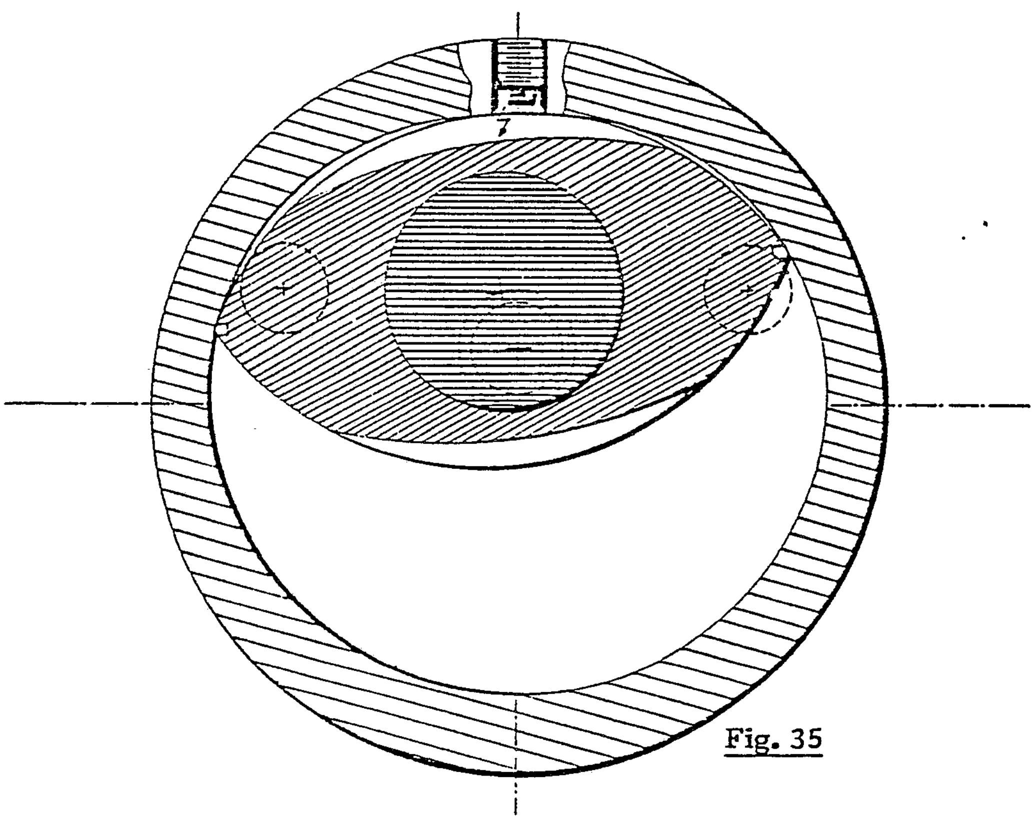


Fig. 35

European Patent Office

PARTIAL EUROPEAN SEARCH REPORT
which under Rule 45 of the European Patent Convention shall be considered, for the purposes of subsequent proceedings, as the European search report

Application number
EP 87 20 1763

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
X	DE - A - 3 244 683 (WILLE)		
	* Page 2, paragraph before last; page 3, last paragraph; figures *	1	F 01 C 1/22
A		4,8	
	--		
X	US - A - 4 308 002 (DI STEFANO)		
	* Column 1, lines 16-37, 50-67; column 2, lines 32-52; figures 1,2; column 3, lines 3-31; figures 3-9; column 4, line 64 - column 5, line 33; figure 10 *	2	
A		5,9,10, 11,12	
	--		
A	DE - A - 2 853 930 (OTTO)		
	* Page 6, last paragraph; page 7, two first paragraphs; figure 9 *	2,9,13	
	--		**TECHNICAL FIELDS SEARCHED (Int. Cl.4)**
A	US - A - 3 244.155 (LAUDET)		
	* Columns 3,4; figures *	13,17, 18	F 01 C
	--		

INCOMPLETE SEARCH -2-

The Search Division considers that the present European patent application does not comply with the provisions of the European Patent Convention to such an extent that it is not possible to carry out a meaningful search into the state of the art on the basis of some of the claims.

Claims searched completely: 1,2,3,5,9,10,14,15,16
Claims searched incompletely: 4,8,11,12,13,17,18,19
Claims not searched: 6,7
Reason for the limitation of the search:

For a big part description and claims rather confusing; many details and elements in the claims not permitting to define clearly the new characteristics to be searched

Place of search	Date of completion of the search	Examiner
THE HAGUE	30-05-1988	KAPOULAS

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

European Patent Office

PARTIAL EUROPEAN SEARCH REPORT

Application number
EP 87 20 1763
-2-

DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	
A	DE - B - 1 194 636 (BETEILIGUNG- UND PATENTVERWALTUNGSGESELLSCHAFT)		
	* Column 3, lines 13-50; figures 1,2 *	17,18	
	--		
A	DE - A - 2 435 598 (GALONSKA)		
	* Pages 5,6; page 8, last paragraph; figures 1-4; page 9 *	3,9,10	
	--		
A	GB - A - 2 095 334 (TROCHOID POWER CORP.)		
	* Page 2, line 89 - page 4, line 12; figures 1,2; page 6 *	14-16	TECHNICAL FIELDS SEARCHED (Int. Cl.4)
