United States Patent [19]

Paul, Jr.

[11] **3,890,941**

[45] **June 24, 1975**

[54] **ROTARY ENERGY CONVERTER**

[76] Inventor: **Herman L. Paul, Jr.,** 720 Old Mill Rd., Wyomissing, Pa. 19510

[22] Filed: **July 15, 1974**

[21] Appl. No.: **488,717**

Related U.S. Application Data

[62] Division of Ser. No. 392,072, Aug. 27, 1973.

[52] **U.S. Cl.** .... **123/44 R;** 123/44 C; 123/44 E; 418/161

[51] **Int. Cl.** **F02b 57/00**

[58] **Field of Search** .... 123/44 R, 44 C, 44 D, 44 E; 418/63, 161, 160

[56] **References Cited**

UNITED STATES PATENTS

1,362,541	12/1920	Rogers	123/44 C
1,557,395	10/1925	Augustine	123/44 E
1,623,296	4/1927	Augustine	123/44 E
2,069,646	2/1937	Cohen	123/8.45
3,139,036	6/1964	McGill	418/63
3,477,415	2/1967	Wyssbrod	123/44 C
3,521,533	7/1970	Van Avermaete	123/44 C

FOREIGN PATENTS OR APPLICATIONS

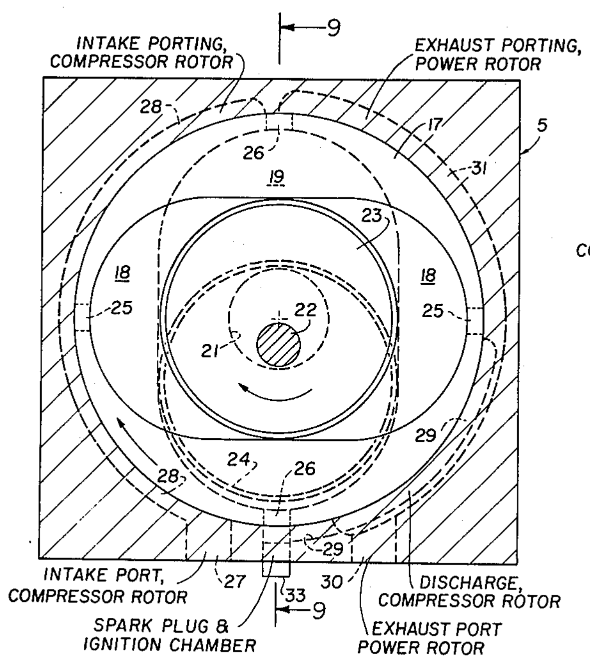
1,000,029	1/1957	Germany	418/161

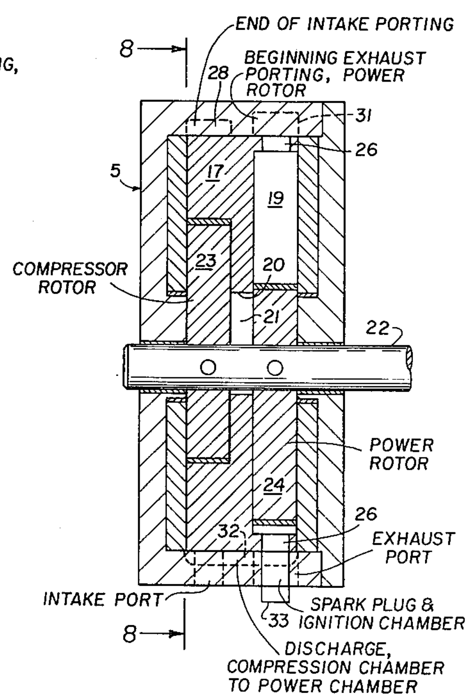
Primary Examiner—Wendell E. Burns
Assistant Examiner—David Reynolds
Attorney, Agent, or Firm—Thomas E. Tate

[57] **ABSTRACT**

The disclosure is that of an invention directed to a rotary energy converter so constructed that it may be used either as an internal or external combustion engine, a fluid pump or as a gas or air compressor. The basic configuration consists of a stationary housing within which is rotatably mounted a disc-like primary circular rotor having a parallel-sided chamber symmetrically disposed with respect to its axis of rotation and a secondary circular rotor rotatable within the parallel sides of the chamber of the primary rotor and eccentrically affixed to a shaft that is mounted within the housing for rotation about an axis that is disposed in parallel offset relation to that of the primary rotor. The relation between the diameter of the secondary rotor within the parallel sides of the chamber of the primary rotor and the distance between the axes of the primary rotor and the shaft being such that for each revolution of the primary rotor with respect to the housing two revolutions of the shaft will occur and that due to the relative motions between the primary and secondary rotors there will be only a single relative revolution between the primary and secondary rotors. The housing and opposite ends of the primary rotor chamber are suitably ported for intake and discharge and the basic configurations may be arranged in multiples for operation with respect to a single shaft common to all secondary rotors. The basic configurations also may be arranged in dual units, each of which functions with suitable inter-stage manifolding as a two stage assembly, in order to provide substantially 360° power operation.

5 Claims, 14 Drawing Figures





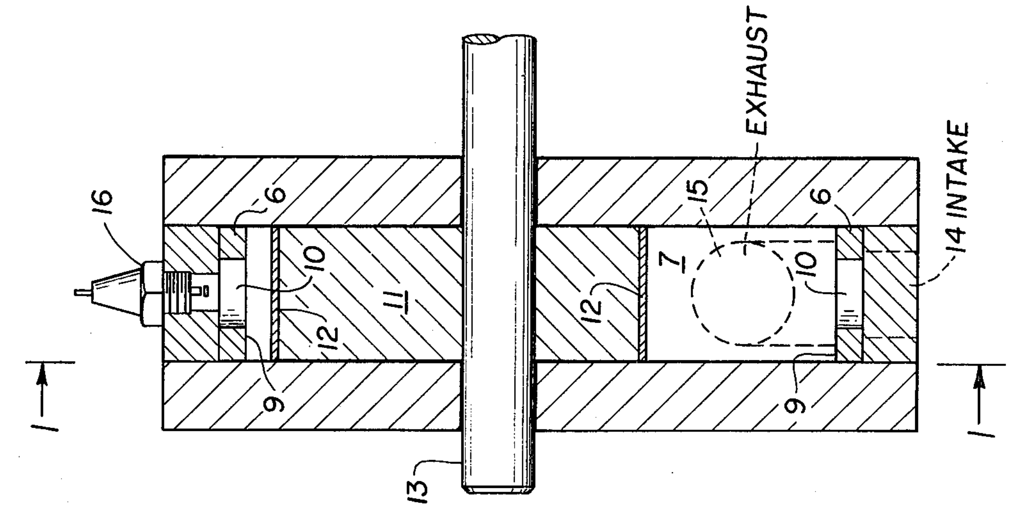

16
6
10
12
11
9
12
15
EXHAUST
7
10
6
14 INTAKE
9
13
1
1

FIG. 7

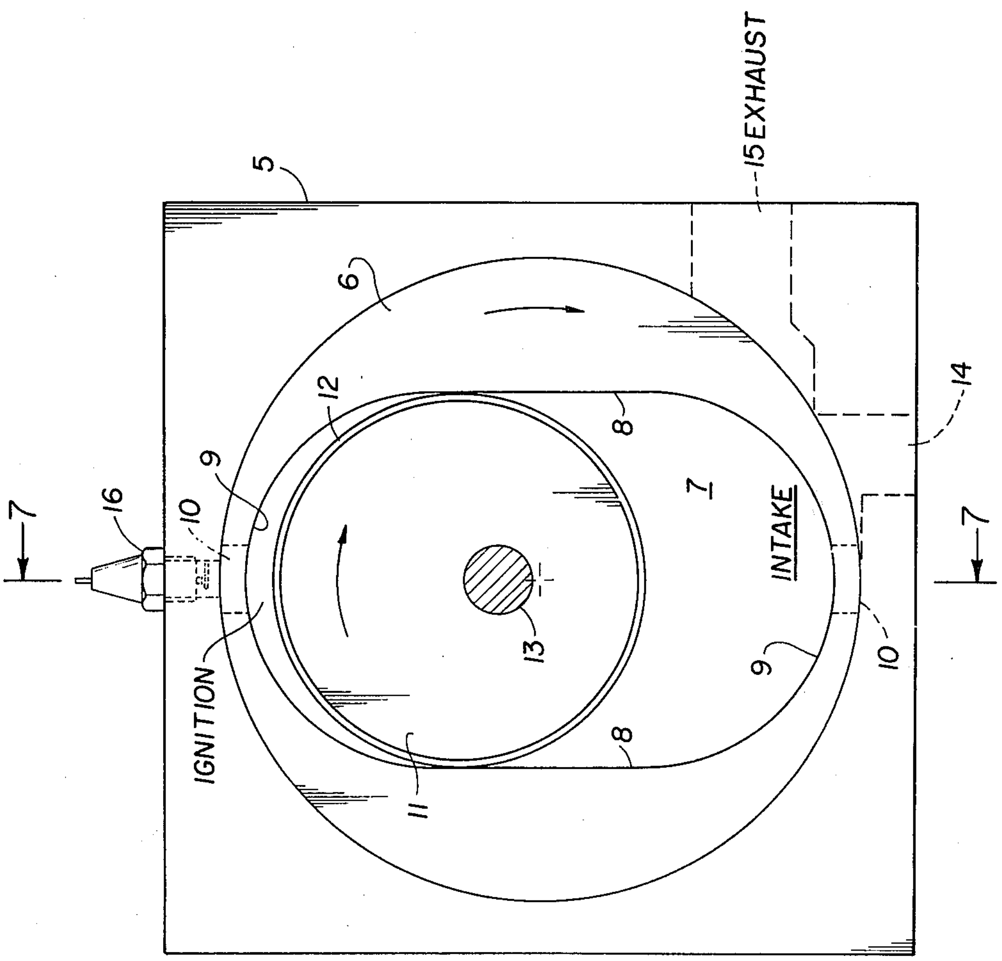

5
15 EXHAUST
6
12
8
14
7
INTAKE
16
10
9
IGNITION
13
9
10
8
11
7
7

FIG. 1

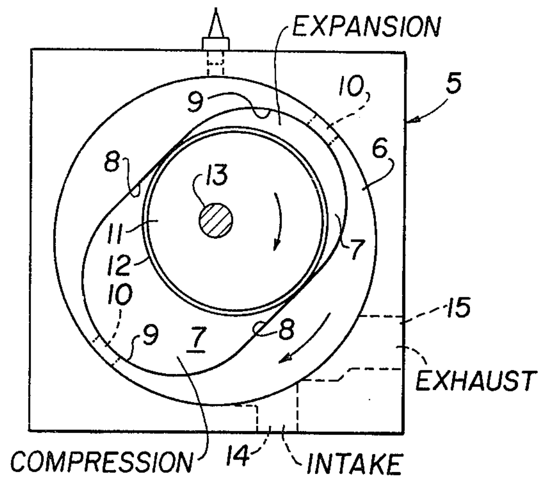


FIG.2

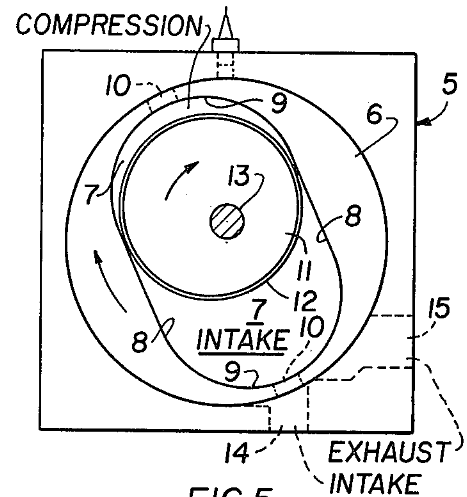


FIG.5

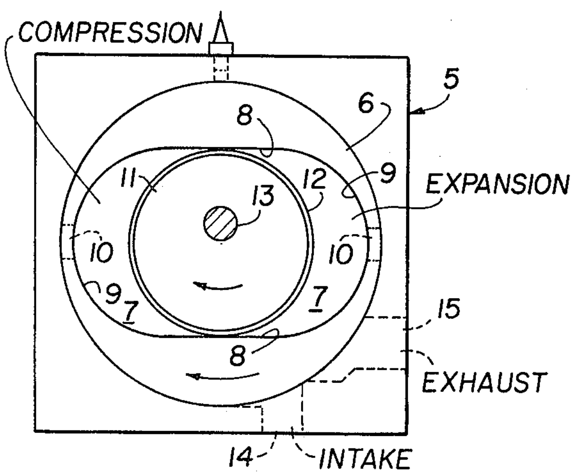


FIG.3

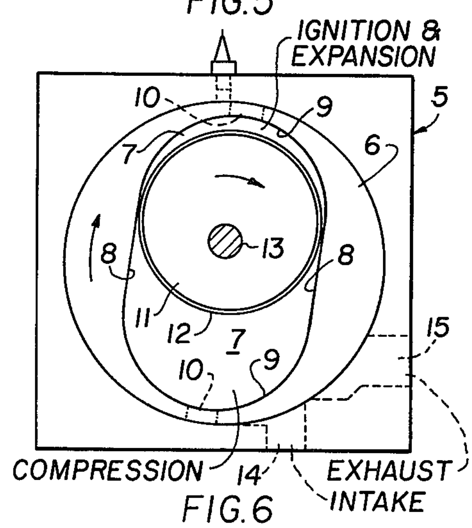


FIG.6

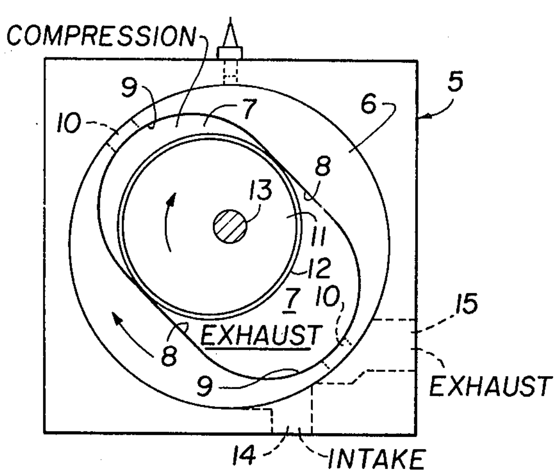


FIG.4

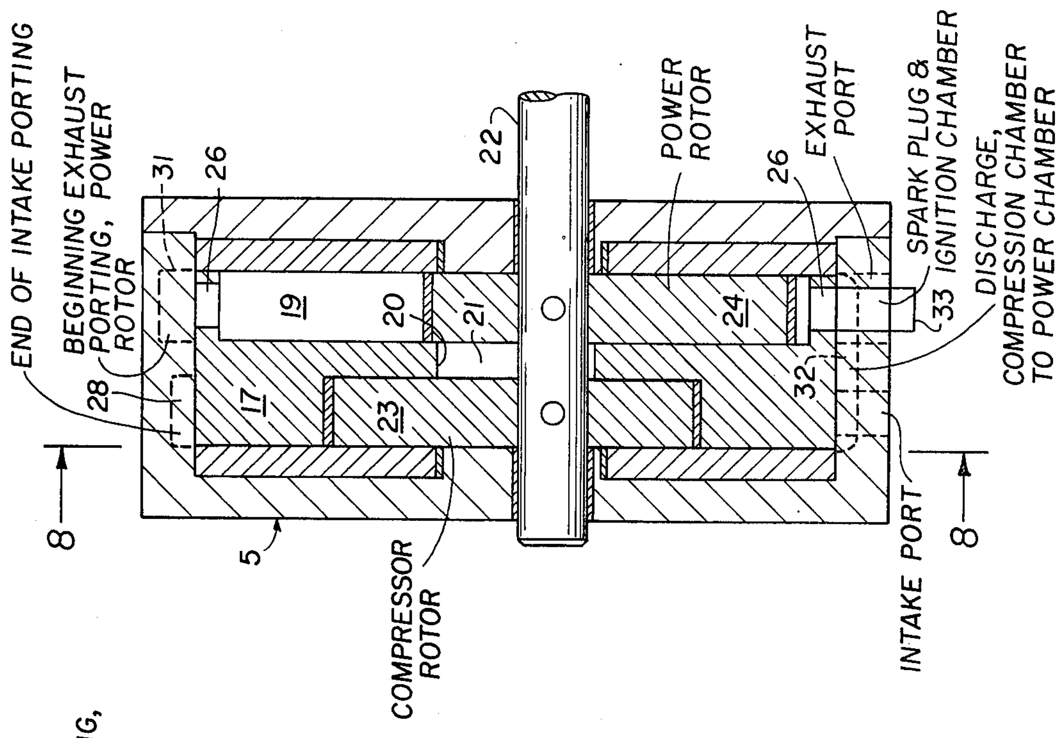

END OF INTAKE PORTING
BEGINNING EXHAUST PORTING, POWER ROTOR
31
26
22
POWER ROTOR
26
EXHAUST PORT
SPARK PLUG & IGNITION CHAMBER
DISCHARGE, COMPRESSION CHAMBER TO POWER CHAMBER
19
20
21
24
33
28
17
23
32
8
5
COMPRESSOR ROTOR
INTAKE PORT
8

FIG.9

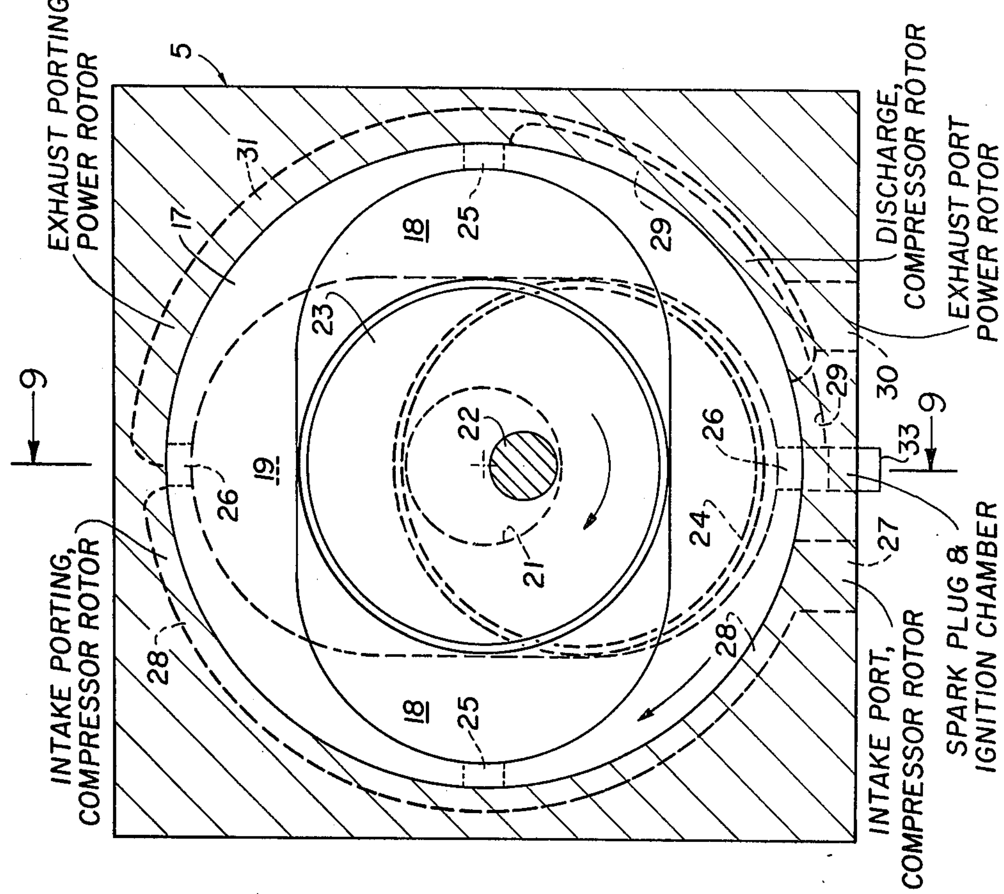

EXHAUST PORTING, POWER ROTOR
5
31
17
18
25
29
DISCHARGE, COMPRESSOR ROTOR
EXHAUST PORT POWER ROTOR
9
23
30
29
22
26
33
9
19
26
24
21
27
INTAKE PORTING, COMPRESSOR ROTOR
28
28
18
25
INTAKE PORT, COMPRESSOR ROTOR
SPARK PLUG & IGNITION CHAMBER

FIG.8

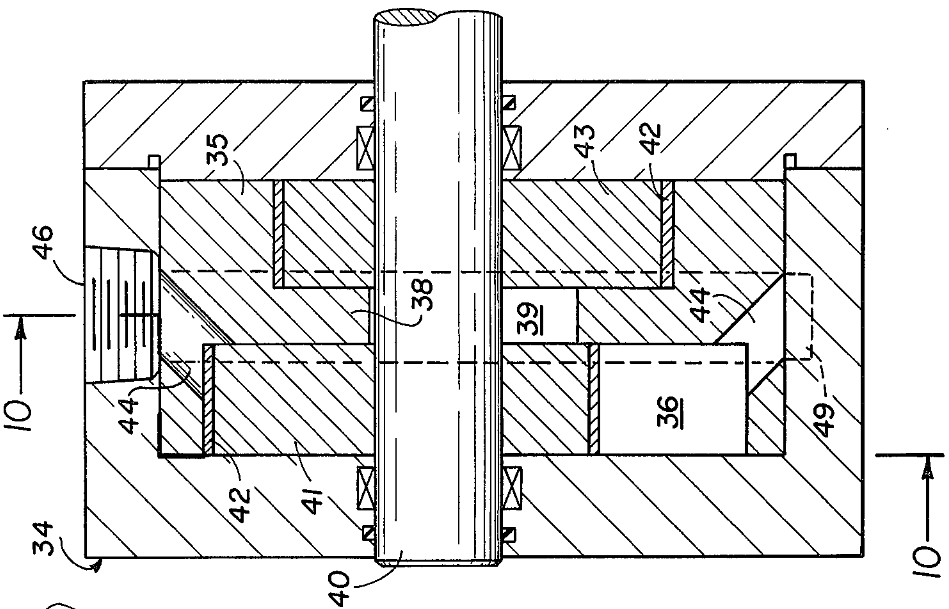


FIG. 11

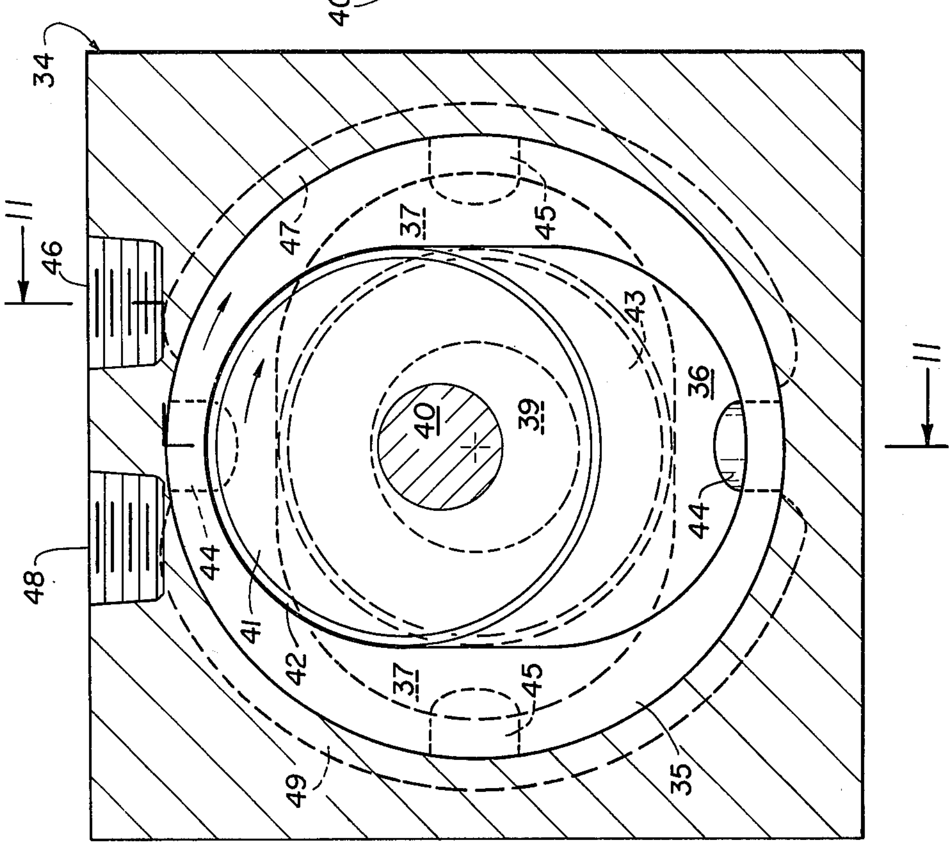


FIG. 10

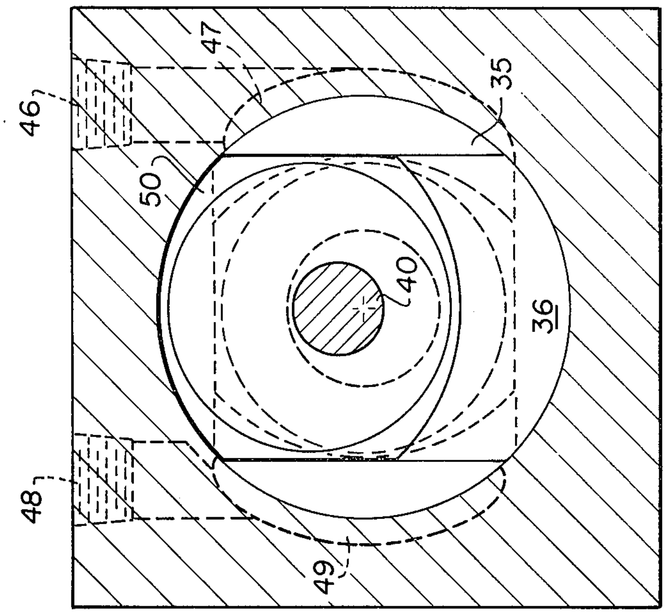


FIG.14

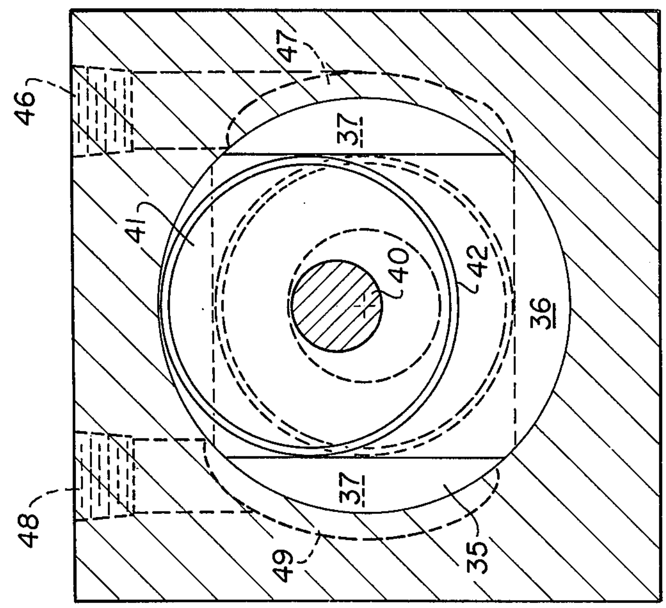


FIG.13

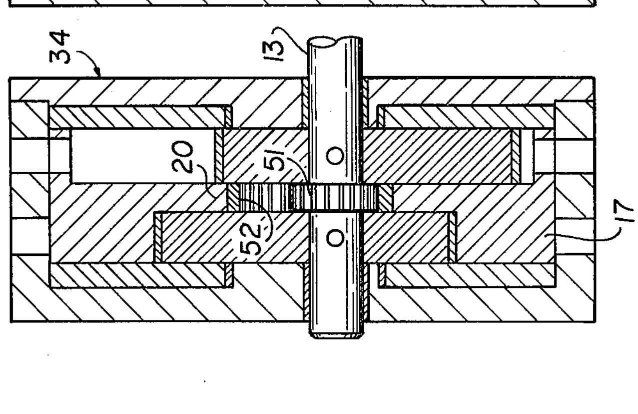


FIG.12

ROTARY ENERGY CONVERTER

RELATED APPLICATION

This application is a division of application Ser. No. 392,072, filed Aug. 27, 1973.

THE INVENTION

This invention relates generally to new and useful improvements in rotary types of internal combustion engines, pumps or compressors and particularly seeks to provide a novel rotary energy converter for such purposes.

Heretofore, such machines typically have required either; (1) the use of a fixed or rotary housing provided with a multi-lobed chamber within which a multi-lobed offset rotor rotates, thus creating one or more variable capacity compression or expansion chambers; or (2) have required the use of axially reciprocable pistons acting against a swash or wobble plate; or (3) have required the use of relatively angularly variable rotor vanes in order to provide the necessary changes in the volumetric capacities of the respective chambers.

For example, the so-called "Wankel" engines or their equivalents are representative of type (1) above; the so-called "Stirling-cycle" engines or their equivalents are representative of type (2) above; and the so-called "Ryenco" engines or their equivalents are representative of type (3) above. These types of engines have been mentioned merely as exemplary of the many different approaches that heretofore have been made in efforts to produce more efficient or simpler types of internal or external combustion engines.

However, even the simpler mechanical approaches, such as those represented by type (1) above, still have not solved the problem since they all appear to require either the use of variable radius or line contact seals, or inherently unbalanced relatively moving parts or complicated valving in order to operate properly, even for relatively limited lengths of time before requiring parts, replacement or rebuilding to restore the desired operating efficiency.

In contrast, a rotary energy machine constructed in accordance with this invention does not require the use of a multi-lobed rotor rotating within a complementary multi-lobed chamber, thus eliminating the variable distance line contact sealing problem between the lobes of the rotor and the walls of the chamber and provides a greatly simplified construction capable of high or low speed operation either as an internal or external combustion engine, as a compressor or expander or as a pump, all of which versions employ essentially the same moving parts operating in the same manner. The machine may be constructed in single, twin or multiple units each of which comprises simply a stationary housing that supports an internal circular primary rotor rotatable about one fixed axis and having a parallel-sided symmetrically disposed chamber extending along a diameter thereof, a drive or driven shaft extending through the housing and rotatable about a second fixed axis that is offset from and parallel to the axis of the primary rotor, and a circular secondary rotor mounted within the chamber of the primary rotor and eccentrically affixed to the drive or driven shaft. The housing is provided with intake and exhaust ports and passages that are complementary to corresponding ports or accesses formed in the primary rotor for communication with the interior of the chamber thereof as the respective ports come into registry during rotation of the primary rotor.

Therefore, an object of this invention is to provide a rotary energy machine that includes essentially only two moving parts namely, a circular primary rotor mounted within a stationary housing for rotation about one fixed axis and having a parallel-sided symmetrically disposed chamber extending along a diameter thereof and a circular secondary rotor mounted within the chamber of the primary rotor between the parallel side walls thereof and eccentrically affixed to a drive or driven shaft carried by the stationary housing for rotation about a second fixed axis that is offset from and parallel to the axis of the primary rotor, whereby to effect cyclically varying increasing and decreasing volumes at the ends of the chamber of the primary rotor as that rotor and the secondary rotor continuously rotate in the same direction at differential speeds.

Another object of this invention is to provide a machine of the character stated in which a sliding seal is effected between the periphery of the secondary rotor and the parallel walls of the chamber of the primary rotor through the use of a ring seal freely mounted on the secondary rotor.

Another object of this invention is to provide a machine of the character stated that can be fabricated in multiple units for operation along a common drive or driven shaft and in which successive units are angularly offset with respect to preceding units to the degree necessary to establish and maintain mechanical and operational balance.

Another object of this invention is to provide a machine of the character stated in which each unit thereof is organized as a two-stage balanced assembly.

A further object of this invention is to provide a machine of the character stated that effects a high ratio of volumetric capacity per unit weight.

A further object of this invention is to provide a machine of the character stated that may be operated at high rotational speeds over prolonged periods of time without substantial loss in efficiency.

A further object of this invention is to provide a machine of the character stated that, when operated as an internal combustion engine, will produce an exhaust containing a minimum of atmospheric pollutants.

With these and other objects, the nature of which will become apparent, the invention will be more fully understood by reference to the drawings, the accompanying detailed description and the appended claims. In the drawings:

FIGS. **1–6** are generally schematic open front elevational views, taken along line **1—1** of FIG. **7**, of a single unit rotary energy machine constructed in accordance with this invention for use as a two cycle internal combustion engine and successively show the relative movements between the primary rotor and the secondary rotor during each full revolution of the secondary rotor;

FIG. **7** is a longitudinal vertical section taken along line **7—7** of FIG. **1** with the relative positions of the intake and exhaust ports indicated in dotted lines in conformity with FIG. **1**;

FIG. **8** is a generally schematic open front elevational view similar to that of FIG. **1**, but taken along line **8—8** of FIG. **9**, and showing a two stage internal combustion unit for substantially 360° power rotation in which the primary rotor is provided with two 90° angularly offset front and back chambers, the front chamber being shown in full lines and the back in dotted lines, and in which a secondary rotor is provided for each chamber and suitable interstage ports and passages are provided within the housing.

FIG. 9 is a vertical longitudinal section taken along line 9—9 of FIG. 8;

FIGS. 10 and 11 are comparable to FIGS. 8 and 9, but illustrate one manner in which the machine may be adapted for use as a hydraulic pump. Here, FIG. 10 is an offset transverse vertical section taken along line 10—10 of FIG. 11 and FIG. 11 is an offset longitudinal vertical section taken along line 11—11 of FIG. 10.

FIG. 12 is a longitudinal section similar to FIG. 9 but additionally showing a pinion gear affixed to the driven shaft and a mating internal ring gear affixed to the primary rotor to maintain a fixed rotative ratio therebetween;

FIG. 13 is a view similar to FIG. 10 but showing a pump modification in which the chambers of the primary rotor are openended; and

FIG. 14 is a view similar to FIG. 13 but showing a specially configured seal ring on each secondary rotor and having a pair of parallel flat faces disposed in sliding contact with the side walls of the respective chambers.

Referring to the drawings in detail the invention, as illustrated, is embodied in a rotary energy machine in which each operative unit or sub-unit, regardless of its end use function, that comprises essentially only three elements namely, a stationary housing, a circular primary rotor having a parallel sided diametric chamber and a secondary rotor rotatable within the chamber of the primary rotor and affixed eccentrically to a drive or driven shaft carried by the housing for rotation about an axis disposed in offset parallel relation with respect to the axis of the primary rotor.

For example, FIGS. 1–7 schematically illustrate how the principles of this may be applied to a single unit for operation as a 2-cycle engine that includes a stationary housing generally indicated 5, and a circular primary rotor 6 mounted within the housing 5 for rotation about its own fixed axis and having a symmetrically disposed diametrically extending internal chamber generally indicated 7 provided with parallel side walls 8, 8, arcuate end walls 9, 9 and end ports 10, 10 extending into open communication with the exterior of the primary rotor. A secondary circular rotor 11, having a peripheral seal ring 12, is mounted within the chamber 7 for relative rotary and lineal movement with respect thereto and is eccentrically affixed to a driven shaft 13 carried by the housing 5 for rotation about a fixed axis disposed in parallel offset relation with respect to the axis of the primary rotor 6. The housing 5 is provided with separate intake and exhaust ports, respectively indicated at 14 and 15, which are located in the path of rotation of the chamber ports 10 in order to become registered therewith as the primary rotor 6 rotates and a spark plug 16 is provided to initiate ignition.

In the operation of the above described embodiment of the invention reference is made to FIGS. 1–7 in which FIGS. 1 and 7 show the parts at a 0° center where a compressed air-fuel charge is ready for ignition at the top of the chamber 7 and a new uncompressed air-fuel charge has been admitted or drawn into the bottom of the chamber 7, and previous startup has occurred so that rotation of the primary and secondary rotors and the driven shaft 13 is taking place in a clockwise direction. In FIG. 2 the primary rotor 6 has moved through an angle of 45° while the secondary rotor 11 has moved through an angle of 90° and power producing expansion of the combustibles in the upper right portion of the chamber 7 is taking place, while the newly admitted air-fuel charge at the lower left portion of the chamber 7 is becoming compressed prior to ignition. In FIG. 3 the primary rotor 6 has moved through an angle of 90° while the secondary rotor 11 has moved through an angle of 180°. This direct and relative rotation of the primary and secondary rotors, and the driven shaft 13, continues so that in the positions shown in FIG. 4 the port 10 at the expansion end of the chamber 7 is passing through registry across the exhaust port 15 to permit discharges of the fully combusted and expanded airfuel mixture, while the opposite port 10 remains closed and the fresh air-fuel mixture at that end of the chamber 7 continues to undergo compression. At the positions shown in FIG. 5, the lower port 10 is passing through registry with the intake port 14 for admission of new air-fuel mixture and the compressed air-fuel mixture at the opposite end of the chamber 7 is approaching the point at which ignition is to occur, while in FIG. 6, the primary rotor has just passed the dead center positions of FIG. 1 and a new power impulse is beginning as the result of ignition of the compressed air-fuel mixture at the top of the chamber 7.

At this point of the description it should perhaps be mentioned that the designation of the rotor 6 as the primary rotor and the rotor 11 as the secondary rotor is used only for the purposes of identification, rather than function, since their actual functions depend upon whether or not this rotary energy machine is engineered for use as an engine, a pump or the equivalents thereof: —if as an engine as described above, the shaft 13 becomes a driven shaft or if as a pump the shaft 13 becomes a driving shaft.

Also, with respect to the above described single unit embodiment of the invention as a two-cycle engine, it is necessary to balance or counterbalance the secondary rotor 11 in order to achieve substantially vibration-free operation.

In contrast, the modification and advance shown in FIGS. 8 and 9 provides an inherently self-balanced two-stage engine unit designed for substantially 360° power rotation.

In this embodiment the stationary housing 5 contains a circular primary rotor 17 provided with a first diametrically disposed front parallel-sided chamber 18 and a second diametrically disposed rear parallel-sided chamber 19 oriented at a 90° angle with respect to the front chamber 18 and separated therefrom by a median web 20 having a central aperture 21 to provide clearance around an offset mounted driven shaft 22 upon which is eccentrically mounted a compressor rotor 23 contained within the front chamber 18 and an eccentrically mounted power rotor 24 contained within the rear chamber 19.

Here, the front chamber 18 is provided with a pair of diametrically opposed end ports 25, 25 for controlling the admission and compression of air-fuel mixtures as will be hereinafter more fully described and the rear chamber 19 is similarly provided with a pair of diametrically opposed end ports 26, 26 for controlling admittance of the compressed air-fuel mixture to the ends of the chamber 19 and its exhaust or discharge therefrom upon completion of combustion and expansion.

For these purposes (see FIG. 8) the stationary housing 5 first is provided at its bottom with an intake port 27, in peripheral alignment with the compressor rotor 23, which communicates with an intake channel 28 formed in the inner wall of the housing 5 and extending around the periphery of the primary rotor 17 to a terminus adjacent the top of the housing and the stationary housing also is provided with a complementary compressor discharge channel 29 located as shown in the lower right quadrant of FIG. 8.

The stationary housing 5 secondly is provided at its bottom with an exhaust port 30, in peripheral alignment with the power rotor 24, which communicates with an exhaust channel 31 formed in the inner wall of the housing 5 and extending around substantially all of the right semi circle of the periphery of the primary rotor 17. A transverse (as viewed in FIG. 9) channel 32 is provided in the housing 5 adjacent the bottom thereof for effecting transfer of each compressed charge of air-fuel mixture from the terminal area of the channel 29 into an end portion of the primary rotor rear chamber 19 through one of the end ports 26 each time one of the ports 26 passes through registry therewith. A spark plug 33 is installed in the housing 5 at the bottom thereof in peripheral alignment with the power rotor 24 and in open communication with the associated end of the transverse channel 32 for ignition purposes.

A clear understanding of the operation of the embodiment shown in FIGS. 8 and 9 can best be gained if it is first understood that the relative positions of the primary rotor 17, the compressor rotor 23 and the power rotor 24 are such that the front chamber 18 is in a horizontal point in its clockwise rotation, the compressor rotor 23 is at its top center and the power rotor 24 is at its bottom center. At this stage, a new charge of air-fuel mixture is being drawn into the left end of the front chamber 18 via the intake port 27 and channel 28 while a previously induced charge of air-fuel mixture is being compressed in the right end of the front chamber 18. Simultaneously at this stage, a previously compressed pre-combustion charge of air-fuel mixture has become admitted to the bottom of the vertically positioned rear chamber 19, via the channels 29 and 32 as the power rotor 24 has approached its bottom center position, while a previously combusted and expanded charge of air-fuel mixture is ready to be exhausted or expelled from the top of the rear chamber 19 via the exhaust channel 31 and exhaust port 30.

Thus, in operation, each new charge of air-fuel mixture is drawn into an associated end of the front chamber 18, as the primary rotor 17 rotates, via the intake port 27, channel 28 and rotor end port 25. As the particular end of the front chamber 18 passes the upper terminus of the channel 28, the associated end port 25 becomes closed off by the wall of the housing 5 and compression of the air-fuel charge begins solely within that end of the front chamber 18 and continues, within a chamber collectively defined by the reducing volume of that end of the front chamber 18, the compressor discharge channel 29 and the transverse channel 32, as soon as the associated end port 25 passes into registry with the beginning of the compressor discharge channel 29.

Compression is maintained within the transverse channel 32 at this stage by the peripheral wall of the primary rotor 17 until one or the other of the end ports 26 of the rear chamber 19 thereof passes through registry therewith to admit the compressed air-fuel mixture into an associated end of the rear chamber 19 in preparation for ignition as soon as that particular end port has passed beyond registry with the transverse channel 32 into and through registry with the spark plug 33, thus producing a power impulse within that end of the rear chamber 19 as the primary rotor 17 continues to rotate.

Once the compressed air-fuel has become contained within the partial chamber defined by the channels 29 and 32 as the result of passage of the associated end port 25 therebeyond, that end port and the associated end of the front chamber 18 again is in condition to draw in a fresh charge of air-fuel mixture as soon as that end port 25 passes through registry with the intake port 27 and its associated intake channel 28.

Concurrently, the ignited compressed air-fuel mixture at the bottom end of the rear chamber 19 expands until that end of the rear chamber 19 reaches its top center, at which point its associated end port 26 passes into and maintains registry with the exhaust channel 31 to effectively expel the combusted products therealong and through the exhaust port 30 as the relative motions between the power rotor 24 and the rear chamber 19 effect a progressive decrease in the volume of that end of the chamber.

Thus, the above described embodiment provides substantially a 360° power operation and inherently is self-balancing due to the 90° offset of the front and rear chambers 18 and 19 and to the 180° offset of the eccentrically mounted compressor and power rotors 23 and 24.

As mentioned above, the principles of this invention also may be readily adapted for use as a pump or compressor and in that connection, FIGS. 10 and 11 schematically illustrate a hydraulic pump constructed in accordance with this invention.

Here, the pump is organized as a twin delivery rotor single unit in order to provide a substantially 360° pumping operation and includes a stationary housing 34 within which is mounted a circular primary rotor 35 for rotation about its own fixed axis and which is provided with a symmetrical parallel-sided diametrically disposed front chamber 36 and an identical rear chamber 37 offset at a 90° angle with respect to the chamber 36 and separated therefrom by a median web 38 having a central aperture 39 to provide clearance for a housing-mounted drive shaft 40, the axis of which is in parallel offset relation to the axis of the primary rotor 35. A front delivery rotor 41, having a slip-ring seal 42 on its periphery is contained within the front chamber 36 and is eccentrically affixed to the drive shaft 40 for rotation therewith and a rear delivery rotor 43, also having a slip-ring seal 42 on its periphery, is contained within the rear chamber 37 and is eccentrically affixed to the drive shaft 40 at an 180° offset with respect to that of the front delivery rotor 41.

The front chamber 36 is provided with a pair of diametrically opposed end ports 44, 44 that are diagonally and radially directed rearwardly to the median periphery of the primary rotor 35 and the rear chamber 37 is provided with a similar pair of diametrically opposed end ports 45, 45 that are diagonally and radially directed forwardly to the median periphery of the primary rotor **35**.

The housing **34** is provided at its top (see FIG. **10**) with an inlet port **46** that opens into communication with an inlet channel **47** formed in the inner median wall of the housing around the general right half of the periphery of the primary rotor **35** and terminating adjacent the bottom thereof. The housing **34** also is provided at its top with an outlet port **48** that opens into communication with an outlet channel **49** formed in the inner median wall of the housing around the general left half of the periphery of the primary rotor **35** and terminating adjacent the bottom thereof at a location separated from the bottom terminus of the inlet channel **47**.

In operation of the pump, the drive shaft **40** is powered by a suitable motor or other drive means to impart uniform clockwise rotary motion to the delivery rotors **41** and **43** and a corresponding clockwise differential rotary motion to the primary rotor **35**. Assuming that the parts at startup are as shown in FIG. **10**, the front delivery rotor **41** is at top center, its associated chamber **36** is vertically aligned and the twin or opposite delivery rotor **43** is at bottom center and its associated chamber **37** is horizontally aligned. As the top end port **44** of the primary rotor **35** passes through registry with the inlet port **46** fluid will be drawn in therethrough and along the inlet channel **47** as the effective volume of that end of the front chamber **36** progressively increases and the fluid will be admitted to the delivery channel **49** after the particular end port **44** passes out of registry with the inlet channel **47** and into continuing registry with the outlet channel **49** so that the fluid will be discharged under pressure from the outlet port **48** as the effective volume of that end of the front chamber **36** progressively decreases to the minimum as the delivery rotor **41** again approaches the top center position shown in FIG. **10**, at which position the end port **44** has passed beyond continuing registry with the outlet channel **49** and the outlet port **48** and is again ready to admit fluid through the inlet port **46** and inlet channel **47** as it moves through continuing registry therewith as heretofore described.

Each of the end ports **44, 44** and **45, 45**, the respectively associated ends of the chamber **36** and **37** and the delivery rotors **41** and **43** function in the manner described above to collectively provide substantially a 360° functional operation of the pump. Thus, with the parts as shown in FIG. **10**, the top of the front chamber **36** is ready to receive fluid through the inlet port **46**, the bottom of the front chamber **36** is filled with fluid ready for discharge through the outlet port **48**, the right end of the rear chamber **37** is receiving fluid through the inlet port **46** and the left end of the rear chamber **37** is discharging fluid through the outlet port **48**, so that a substantially continuous intake and discharge of the pumped fluid is achieved.

In the event that wider porting at the ends of the chambers **36** and **37** and a consequent reduction in the lengths of the inlet and outlet channels **47** and **49** are required, as may be the case when extremely low viscosity fluids or gases are to be pumped or compressed, the chambers **36** and **37** may be open-ended as shown in FIG. **13**, rather than closed and end-ported as previously described, while still retaining the slip-ring seals **42** on the delivery rotors. This of course would effect an oddly-shaped but still symmetrical plan profile at the ends of the chambers. Accordingly, if it is either desirable or necessary to maintain the generally lunate plan profile at the ends of the chambers for any purpose, the slip-ring seal **42** may be replaced by a modified slip-ring seal **50** as shown in FIG. **14**, which has parallel sides for sliding engagement between the parallel side walls of the chambers of the primary rotor **35** and arcuate ends whose radii correspond to that of the periphery of the primary rotor **35**.

It should be understood that, regardless of whether or not the principles of this invention are embodied in an engine, a pump or any other adaptation, it is important to assure that a 1:1 rotational ratio be maintained between the housing and the primary rotor, a 2:1 rotational ratio be maintained between the housing and the drive or driven shaft and a relative 1:1 rotational ratio be maintained between the primary rotor and any secondary rotor. Such ratios are established naturally by the relative dimensions of the parts in relation to the eccentricity of the secondary rotors and the parallel separation between the axis of the primary rotor and the axis of the drive or driven shaft and easily may be maintained, as shown in FIG. **12** for example, in which the driven shaft **13** is provided with a fixed pinion gear **51** for rotation within the aperture of the median web **20** and meshed with a complementray internal ring gear **52** affixed to the median web **20** of the primary rotor **17**.

Furthermore, it should be understood that the previously described embodiments, or any modifications thereof, may be arranged in multiples for operation about a common drive or driven shaft or separately installed as multiple units that collectively may be connected to a common drive or driven shaft through suitable gearing or other power transfer means.

It also should be understood that while the various ports and channels have been described as illustrated in the several embodiments or modifications of the invention, such portings or channelings may be varied within wide limits, depending upon the end uses of the machines or upon the nature of the throughput gases, mixtures or liquids and the end result desired. It also should be understood that, in a somewhat broader sense, variations in arrangements and proportions of parts may be made within the scope of the appended claims.

I claim:

1. In a rotary energy converter, a fixed housing provided with a cylindrical chamber for receiving and operably supporting a primary rotor, said housing being provided with an intake port and an exhaust port extending from the exterior thereof into open communication with the interior of said cylindrical chamber; a circular primary rotor mounted within said cylindrical chamber for rotation about its own fixed axis; said primary rotor being provided with a first symmetrical diametrically-extending parallel-sided chamber having its opposed ends arranged for open communication with the exterior of said primary rotor for passing communication with said intake port and with an intake channel associated therewith; a first circular secondary rotor operably positioned within the said first chamber of said primary rotor between the parallel sides thereof, said first secondary rotor being eccentrically affixed to a shaft operably mounted in said housing for rotation about an axis disposed in parallel offset relation with respect to the axis of rotation of said primary rotor; said primary rotor being provided with a second symmetrical diametrically-extending parallel-sided chamber having its opposed ends arranged for open communication with the exterior of said primary rotor for passing communication with said exhaust port and with an exhaust channel associated therewith, said second parallel-sided chamber having its longitudinal axis oriented at an angle with respect to the longitudinal axis of said first parallel-sidedchamber, said first and second parallel-sided chambers being separated by a median web having a central aperture whereby to provide clearance around said shaft; a second circular secondary rotor operably positioned within said second parallel-sided chamber between the parallel sides thereof and being eccentrically affixed to said shaft at an orientation complementary to the longitudinal axis of said second parallel-sided chamber; one portion of the wall of said cylindrical chamber being provided with an intake channel having an end in open communication with said intake port and another portion of the wall of said cylindrical chamber being provided with a discharge channel, said intake and discharge channels lying in the general plane of said first parallel-sided chamber; the wall of said cylindrical chamber being provided with a transfer channel having one end in open connunication with an end of said discharge channel and its other end extending for communication with the said second parallel-sided chamber; another portion of the wall of said cylindrical chamber being provided with an exhaust channel having one end in open communication with said exhaust port and its other end closed, said exhaust channel lying in the general plane of said second parallel-sided chamber; and a spark plug mounted on said housing intermediate said intake and exhaust ports and extending radially inwardly toward communication with said second parallel-sided chamber whereby to permit said rotary energy converter to operate as a two-stage internal combustion engine.

2. The rotary energy converter of claim **1** additionally including a slip-ring seal mounted on the periphery of each of said first and second secondary rotors.

3. The rotary energy converter of claim **1** additionally including gearing connections between said primary rotor and said shaft for maintaining a predetermined rotational ratio therebetween.

4. The rotary energy converter of claim **3** in which said gearing connections, for a 1:1 rotational ratio between said housing and said primary rotor, maintain a 2:1 rotational ratio between said housing and said secondary rotors and their common shaft and maintain a 1:1 relative rotational ratio between said primary rotor and said secondary rotors and their common shaft.

5. The rotary energy converter of claim **1** in which the opposed ends of said first and second parallel-sided chambers are closed by arcuate end walls and in which the said arrangements for open communication with the exterior of said primary rotor comprise ports extending through said arcuate end walls.

* * * * *