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Dean, Jr. [45] May 7, 1974

[54] **ROTARY POWER TRANSLATION MACHINE**

[76] Inventor: **John K. Dean, Jr.,** 8007 Green Willow Court St., Huntsville, Ala. 35802

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[21] Appl. No.: **306,570**

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[51] **Int. Cl.** **F02b 53/00**
[58] **Field of Search** 123/8.19, 8.23, 8.27, 8.29, 123/8.31, 8.41, 8.43, 8.47; 418/195, 207

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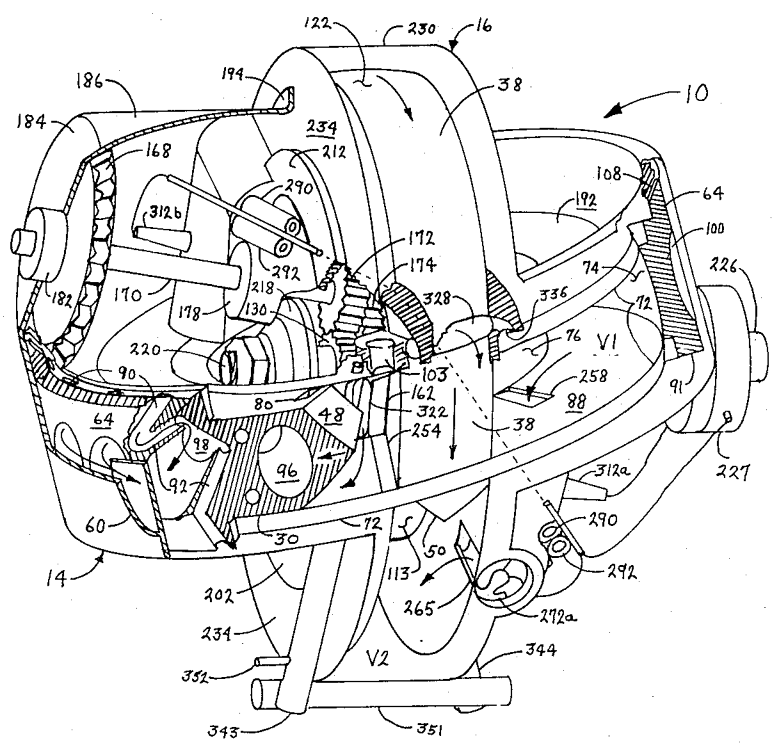
Primary Examiner—Carlton R. Croyle
Assistant Examiner—Michael Koczo, Jr.

[57] **ABSTRACT**

A rotary internal combustion engine wherein a pair of rotors operate synchronously in crossing orbital cavities and wherein a fuel-air mixture is drawn in and compressed by one rotor in one cavity, the compressed mixture fed to a precombustion chamber and therein ignited and fed into the other cavity to drive the second rotor and the engine.

14 Claims, 33 Drawing Figures



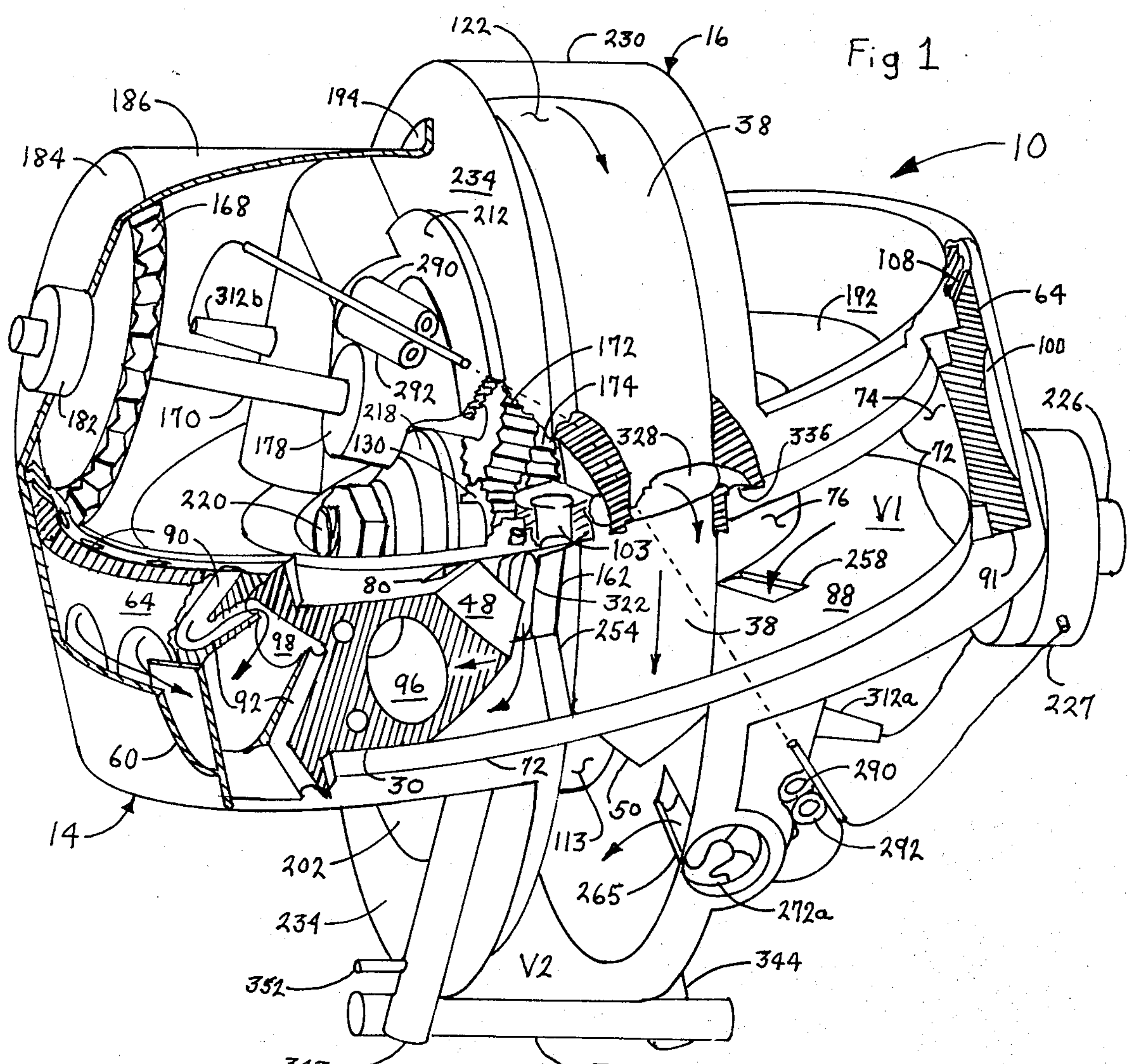


Fig 1
122
230
16
10
186
194
184
234
38
168
212
290
108
312b
192
64
100
172
292
174
74
226
182
170
218
130
178
328
336
72
76
V1
220
90
103
258
162
80
322
48
88
64
98
254
38
91
92
96
312a
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72
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272a
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V2
344
352
343
351

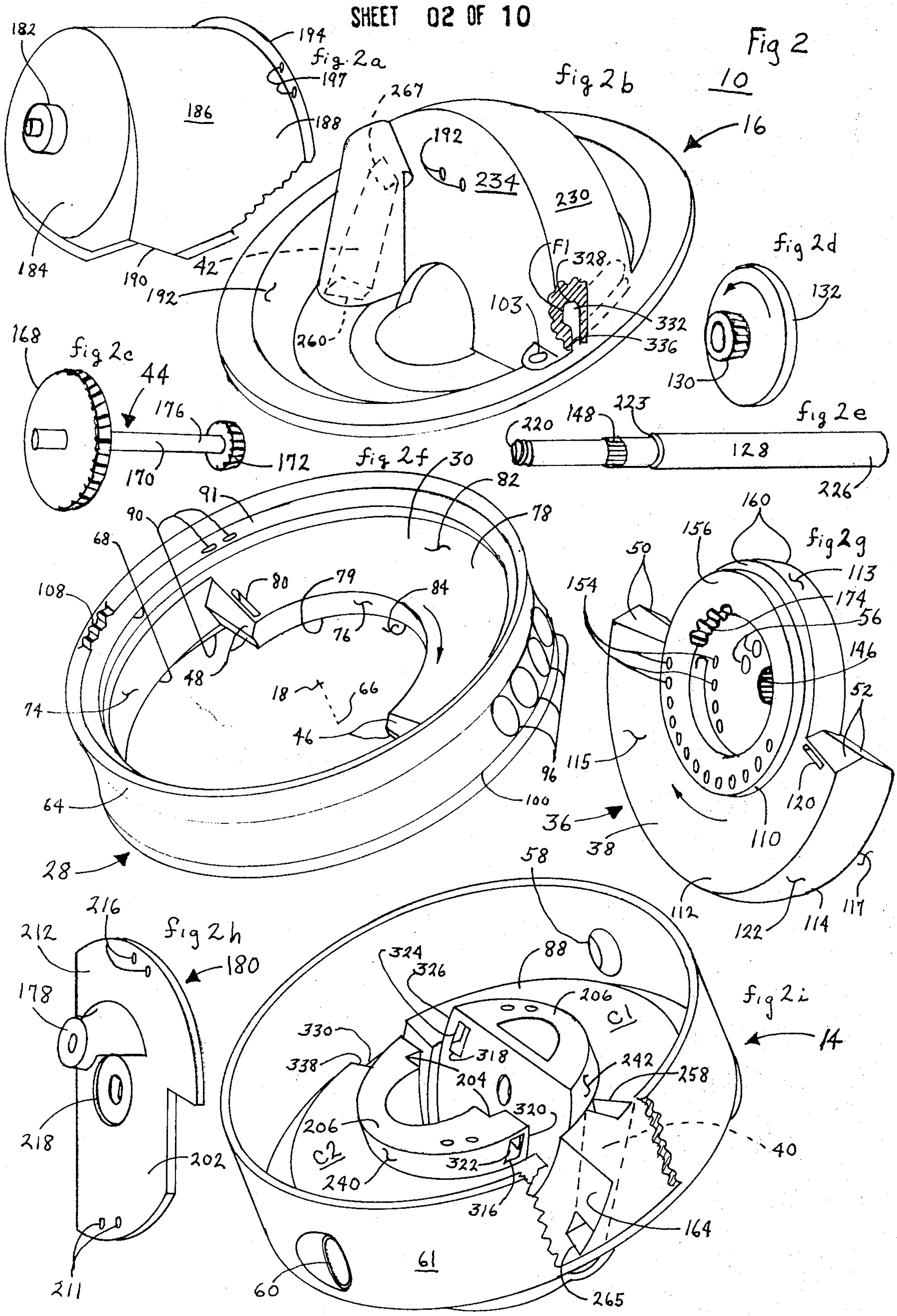


Fig 2
10
fig 2a
fig 2b
fig 2c
fig 2d
fig 2e
fig 2f
fig 2g
fig 2h
fig 2i

Fig. 4a

Fig. 4b

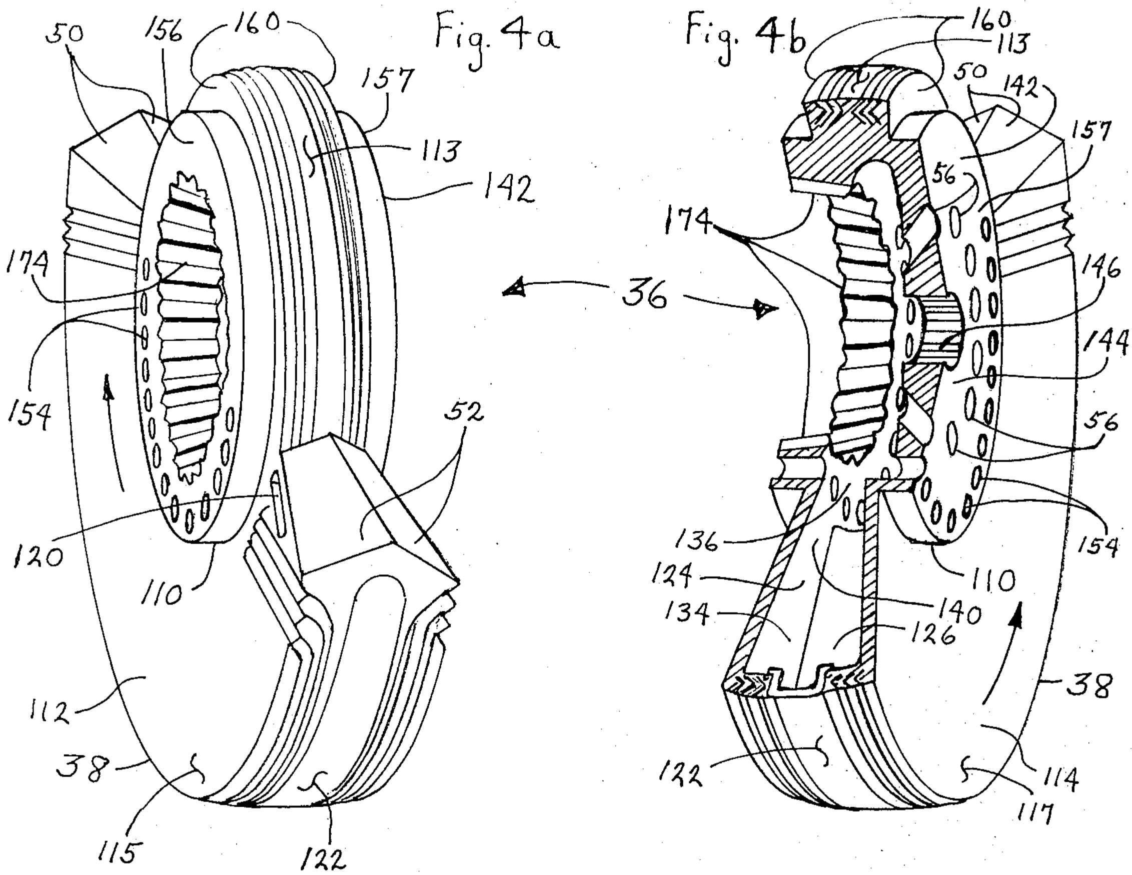


Fig. 3

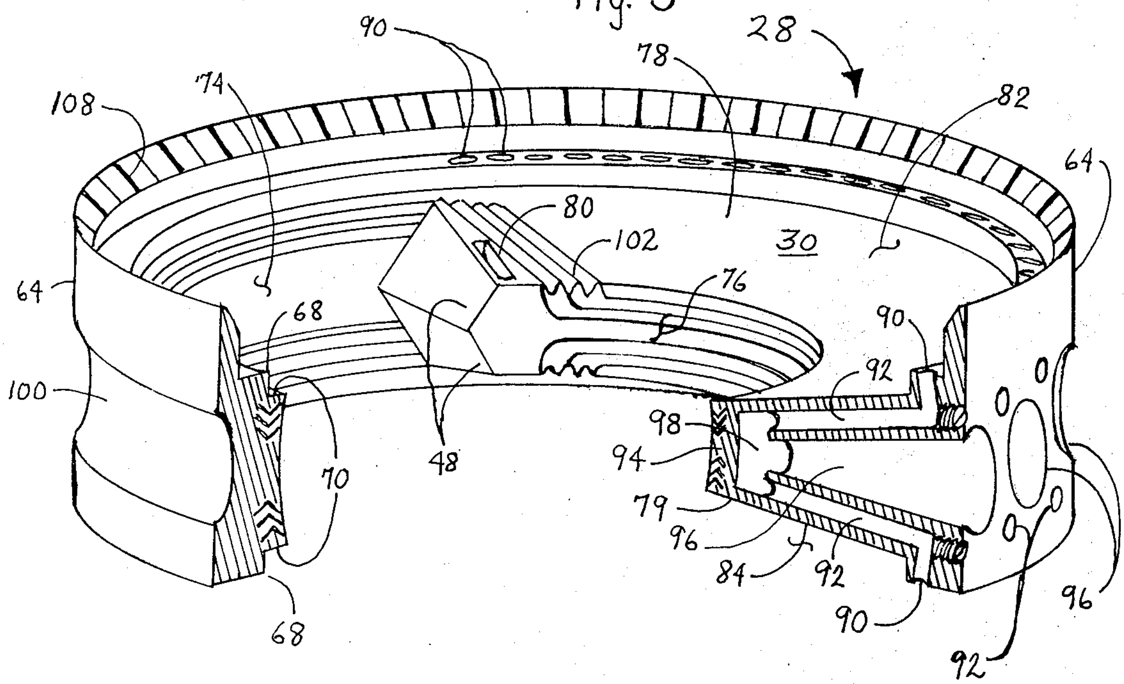


Fig. 4c

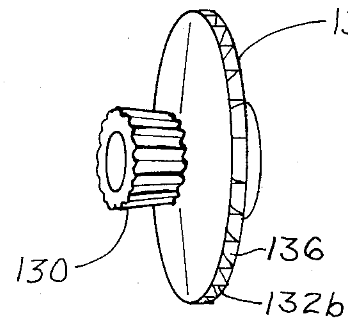


Fig. 4d

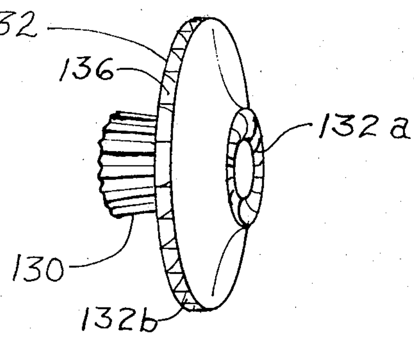
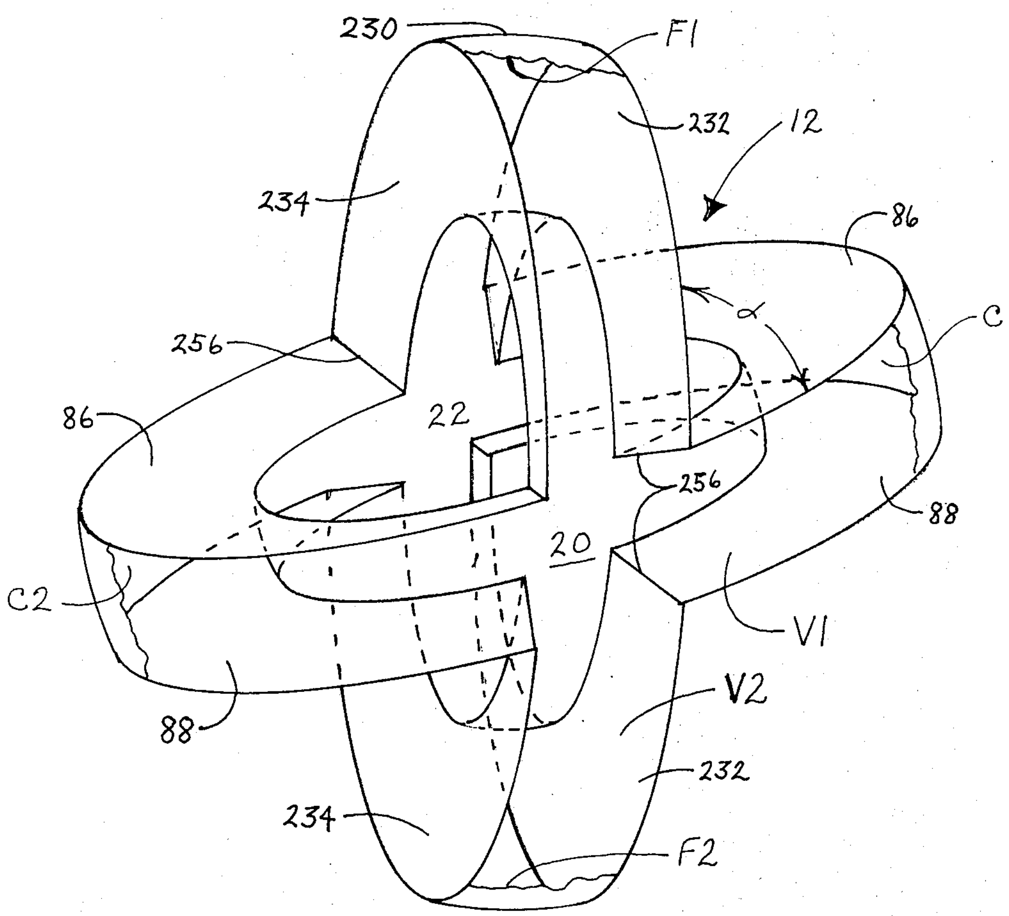


Fig. 5



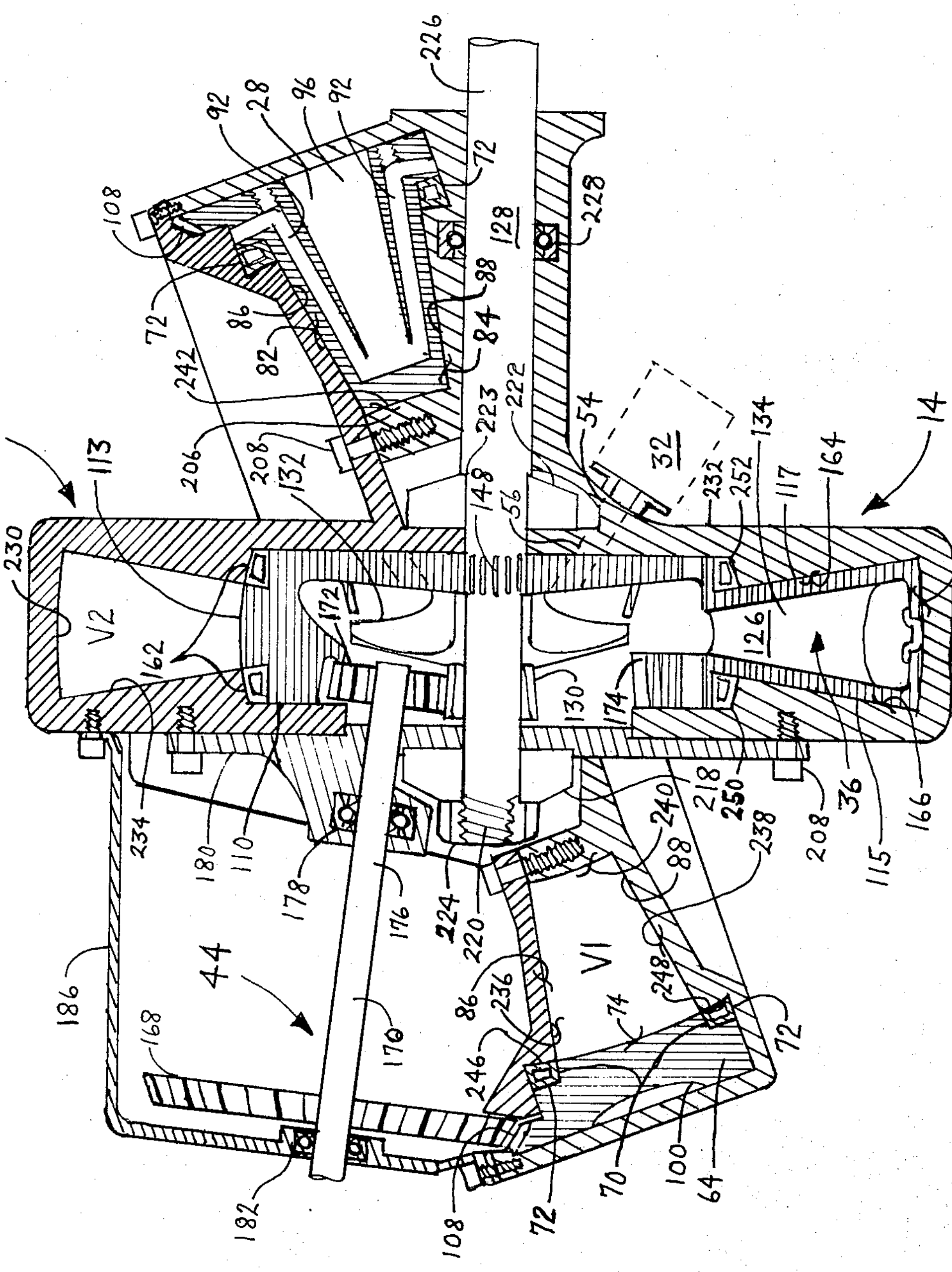
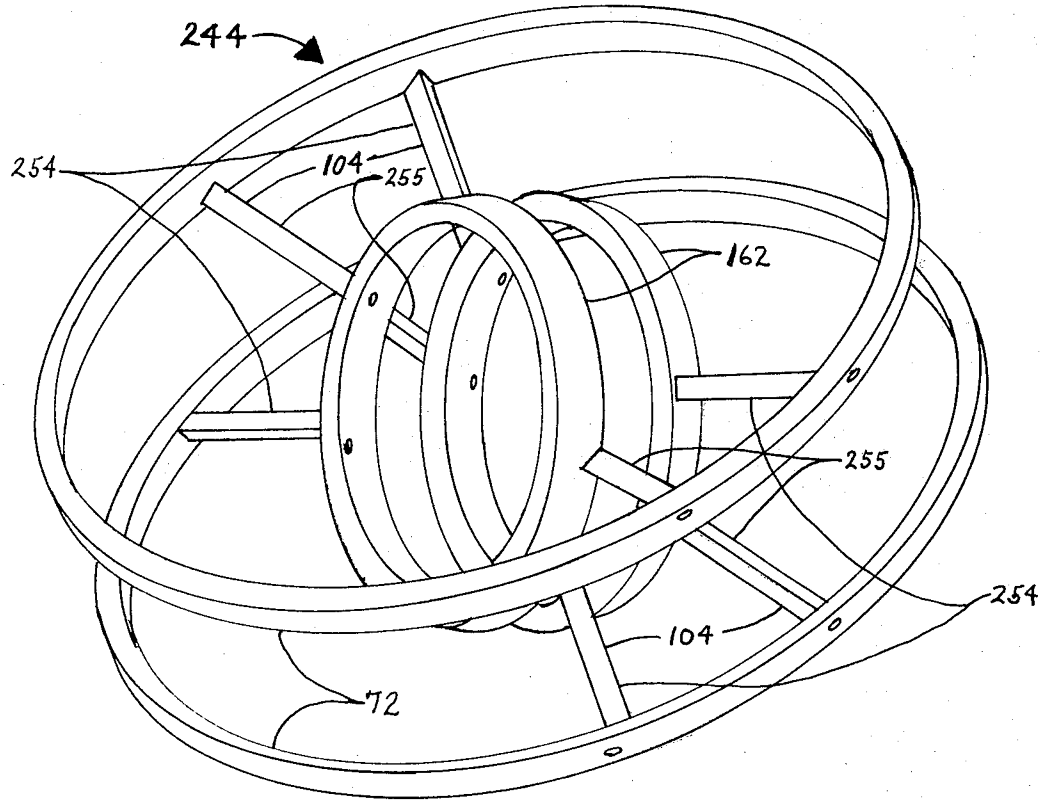


Fig. 6

Fig. 6a



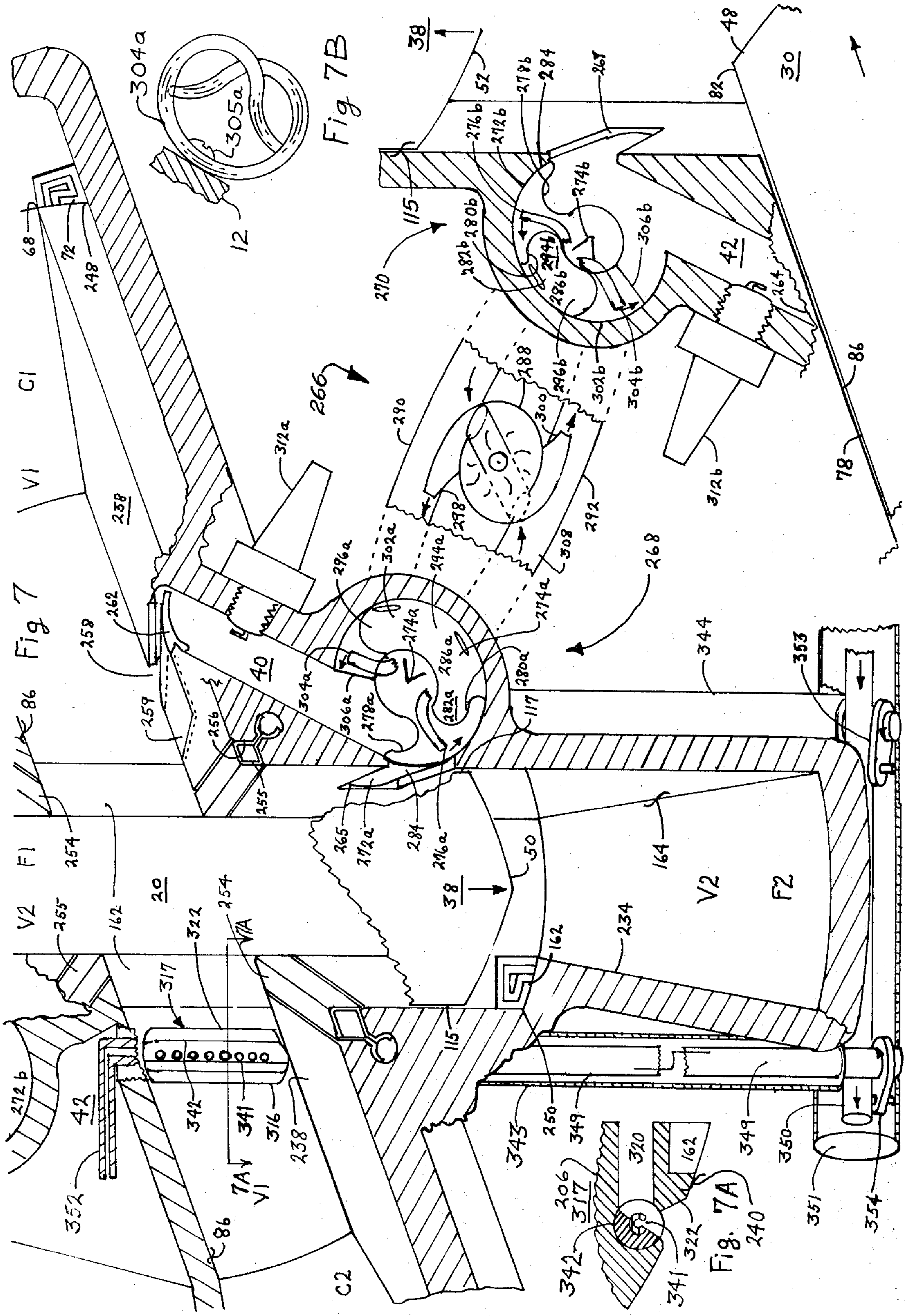


Fig 7
Fig 7A
Fig 7B

Fig. 8a 0°

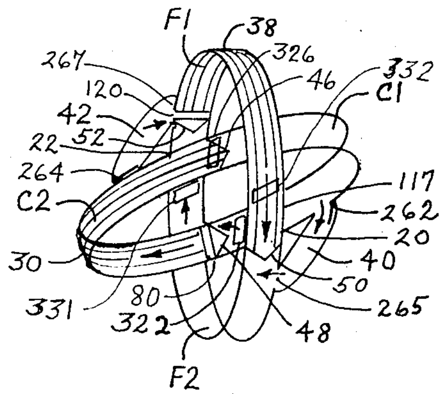


Fig 8b 28°

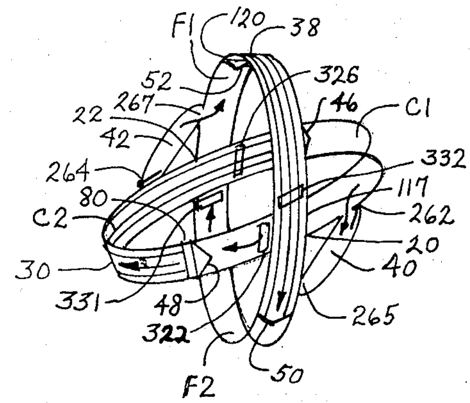


Fig. 8c 112°

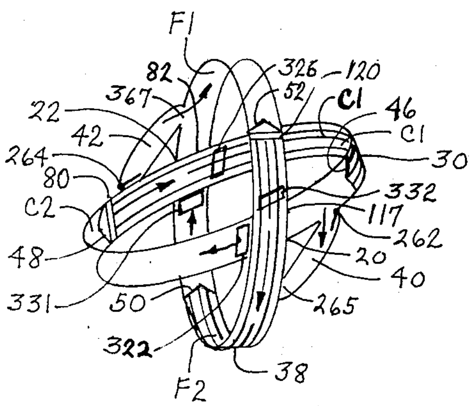


Fig. 8d 147°

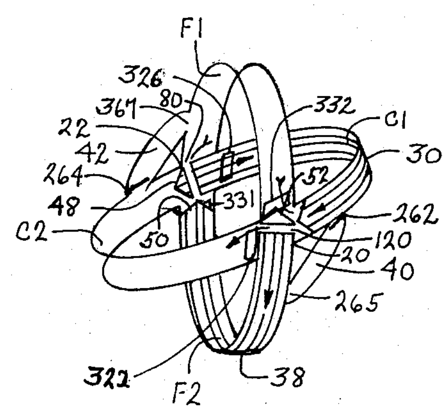


Fig. 8e 160°

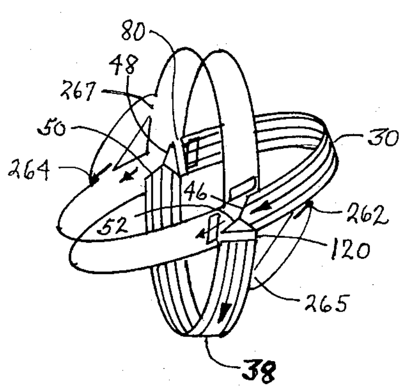


Fig 8f 173°

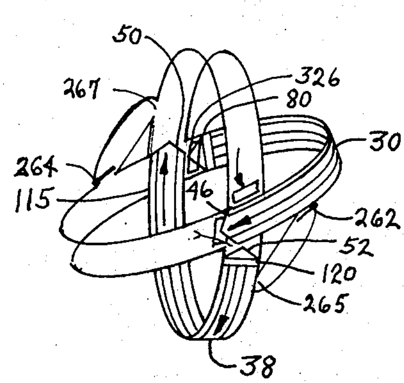


Fig. 8g 180°

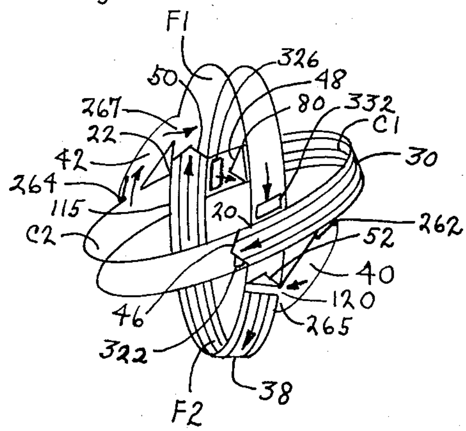


Fig. 8h 208°

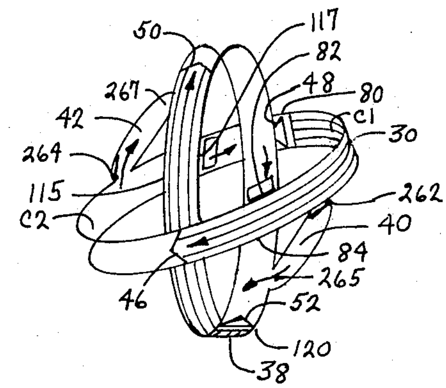


Fig. 8i 292°

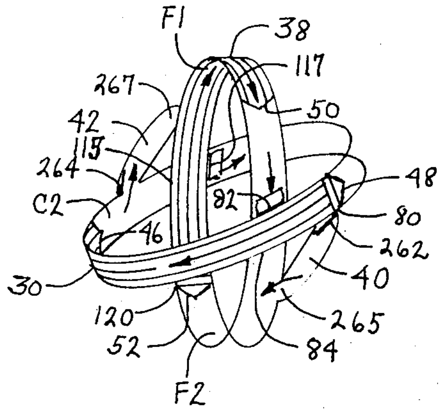


Fig 8j 327°

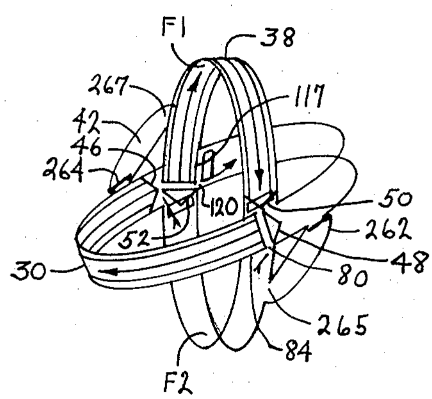


Fig. 8k 340°

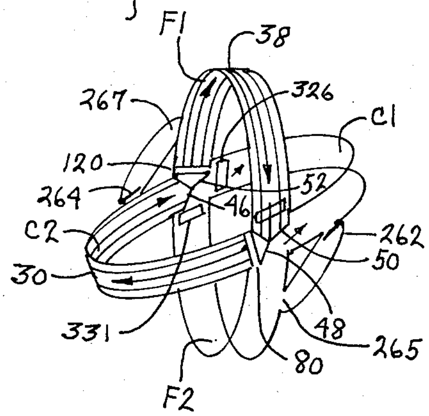
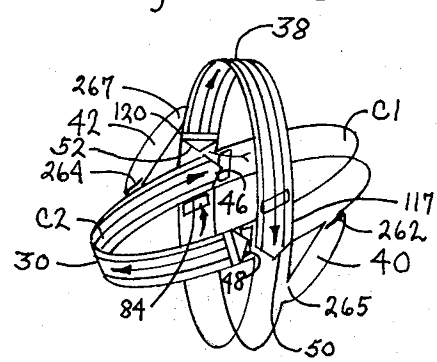


Fig. 8l 353°



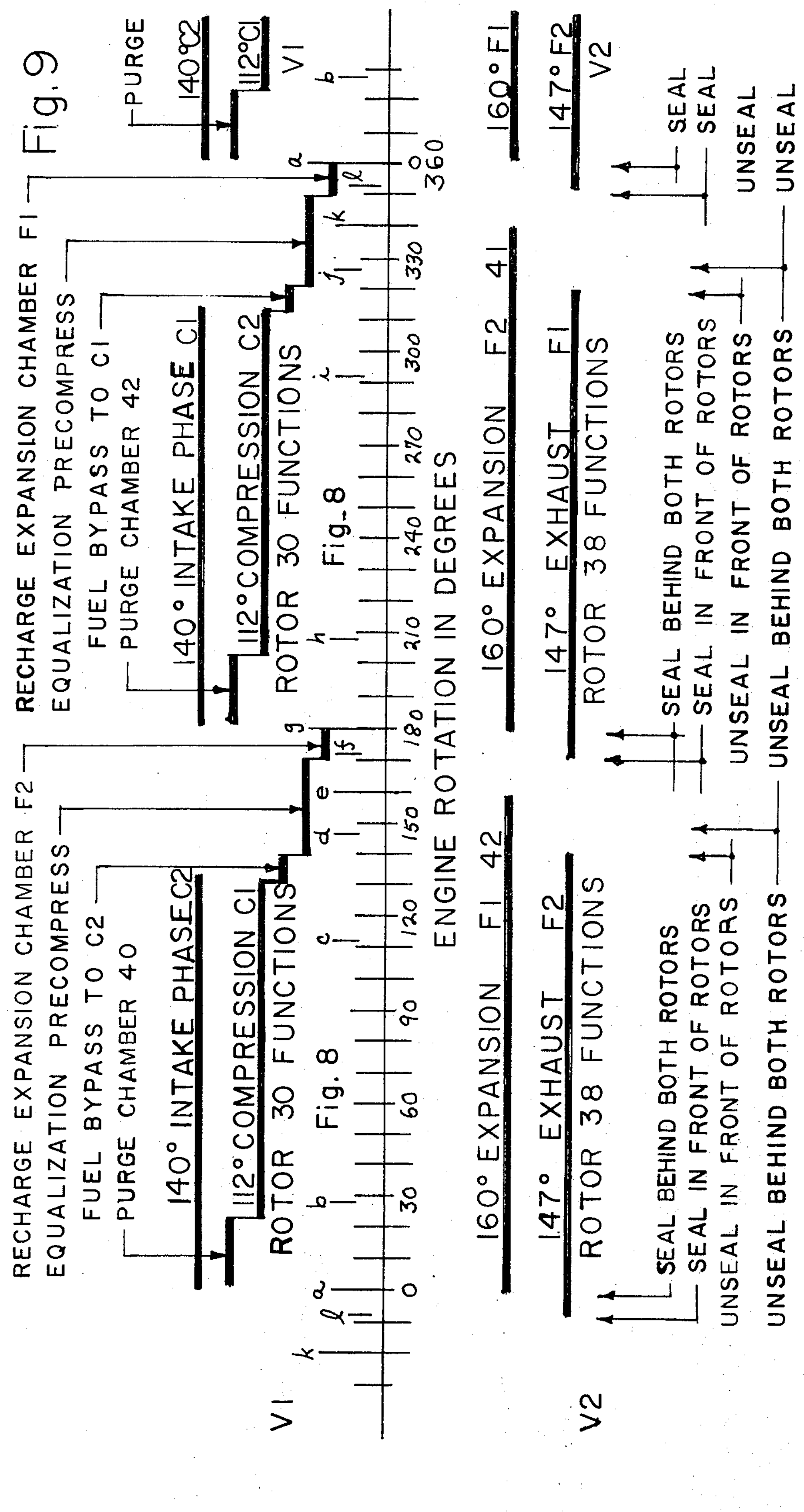


Fig. 9
RECHARGE EXPANSION CHAMBER F2
EQUALIZATION PRECOMPRESS
FUEL BYPASS TO C2
PURGE CHAMBER 40
140° INTAKE PHASE C2
112° COMPRESSION C1
ROTOR 30 FUNCTIONS
Fig. 8
RECHARGE EXPANSION CHAMBER F1
EQUALIZATION PRECOMPRESS
FUEL BYPASS TO C1
PURGE CHAMBER 42
140° INTAKE PHASE C1
112° COMPRESSION C2
ROTOR 30 FUNCTIONS
Fig. 8
PURGE
140° C2
112° C1
V1
V2
0 30 60 90 120 150 180 210 240 270 300 330 360
ENGINE ROTATION IN DEGREES
160° EXPANSION F1 42
147° EXHAUST F2
ROTOR 38 FUNCTIONS
160° EXPANSION F2 41
147° EXHAUST F1
ROTOR 38 FUNCTIONS
160° F1
147° F2
SEAL BEHIND BOTH ROTORS
SEAL IN FRONT OF ROTORS
UNSEAL IN FRONT OF ROTORS
UNSEAL BEHIND BOTH ROTORS
SEAL
SEAL
UNSEAL
UNSEAL

ROTARY POWER TRANSLATION MACHINE

BACKGROUND OF THE INVENTION

This invention generally relates to rotary internal combustion engines.

Rotary engines have been disclosed in the literature and various ones of them constructed during at least the past 30 years. Despite this, only in the past few years has the rotary engine presented anything like a challenge to the reciprocating engine. At this time it is believed that there is only one such engine which has enjoyed any significant popularity. While use of this engine is expanding and its performance has been proven as a successful automotive engine, it has been popularly reported that fuel economy, both as to gas and oil, has not come up to that of certain comparatively powered reciprocating engines.

SUMMARY OF THE INVENTION

It is the object and purpose of this invention to provide a new and improved rotary engine wherein substantial advancements are made in engine construction, performance and efficiency.

In accordance with the invention there is provided a pair of like dimensioned toroidal trucks or cavities having a common center and oriented to intersect at an included angle of 50° to 90°. A rim mounted rotor rotates in one cavity and a hub mounted rotor rotates in the other cavity, crossing in two opposed common cavity regions. One of the rotors and its associated cavity functions to draw in and compress an air-fuel mixture. The other rotor-cavity combination is interconnected to the intake-compressor rotor-cavity combination by two pre-combustion chambers related by 180°. The second rotor-cavity combination receives an ignited and thus expanding fuel mixture from the first one, and then the other of the pre-combustion chambers to drive this rotor and the engine.

Other objects, features are disclosed in the following specification when considered together with the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a three dimensional diagrammatical illustration of the basic configuration of the engine of this invention.

FIGS. 2*a*–2*i* are pictorial views generally showing the organization of the basic components of the engine and wherein:

FIG. 2*a* is of a gear cover;

FIG. 2*b* is of an engine head assembly;

FIG. 2*c* is of a gear assembly for interconnecting rotors of the engine;

FIG. 2*d* is of a rotary compressor rotor;

FIG. 2*e* is of the main shaft;

FIG. 2*f* is of an intake-compression rotor;

FIG. 2*g* is of an expansion-exhaust or power rotor;

FIG. 2*h* is of a central support plate assembly; and

FIG. 2*i* is of a detachable engine block assembly.

FIG. 3 is a perspective view, partially cut away, showing in greater detail the intake-compression rotor.

FIGS. 4*a* and 4*b* are left and right side perspective views of the power rotor, the latter being partially cut away. FIGS. 4*c* and 4*d* are pictorial views of the left and right sides of the rotary compressor rotor, respectively.

FIG. 5 is a three dimensional diagram of the intersecting cavities in which the intake-compression and expansion-exhaust rotors operate.

FIG. 6 is a sectional view of the engine with a cut taken parallel with and near the main shaft of the engine. FIG. 6*a* is a three dimensional view illustrating the position of the gas seals installed in the engine.

FIG. 7 is a diagrammatic illustration of a portion of the engine and particularly illustrates combustion chambers and valve porting systems for the precombustion chambers.

FIG. 7A is a sectional view along lines 7A—7A of FIG. 7, illustrating a detail of the construction of the carburetor employed in one embodiment of the invention.

FIG. 7*b* is a side view showing an example of a complete spring or springs **304*a*** and **304*b*** partially shown in FIG. 7.

FIGS. 8*a*—8*l* are schematic illustrations of the progressive positions of rotors during 360° of rotation of the engine.

FIG. 9 is a time chart summarizing the events which occur during the 360° of rotation illustrated in FIGS. 8*a*—8*l*.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring initially to FIGS. **1**, **2*a*–2*i*** and **5**, the internal combustion engine **10** shown therein is housed in enclosure **12** which consists of a support block assembly **14** (FIG. 2i) and detachable head assembly **16** (FIG. 2*b*). In general enclosure **12** houses a pair of like dimensioned toroidal tracts or cavities **V1** and **V2** (FIG. **5**) having a common center **18**, and one of which cavities, **V1**, intersects the other cavity **V2** within two diametrically opposite regions **20** and **22**, the cavities being inclined at relative angle α of approximately 70°. The opposite or intersecting regions **20** and **22**, being common to both cavities **V1** and **V2** are also referred to as cross-overs or intersections. Rim-mounted rotary assembly or compressor rotor assembly **28**, shown in FIG. 2f, includes an intake-compression rotary piston or rotor **30** which rotates in cavity **V1** and functions to draw in and compress a fuel-air mixture from carburetor **32**, mounted on support block **14** (FIG. **6**). Hub-mounted rotary assembly or power rotor assembly **36** includes an expansion-exhaust rotary piston or rotor **38** which travels in cavity **V2** and which is driven by the fuel-air compressed charge received from cavity **V1**, exploded in either one of two pre-combustion, or cavity coupling, chambers **40** and **42**, and which functions to expel exhaust gases. Rotary pistons **30** and **38** fill half of the volume of enclosure **12** and are synchronously coupled for like speed rotation by gear assembly **44** (FIG. 2*c*) such that approaching and receding ends **46** and **48** of intake-compression rotary piston **30** and receding and approaching ends **52** and **50** of expansion-exhaust rotary piston **38**, respectively, as shown in FIG. 8*e*, pass without interference in cross-overs **20** and **22**. As rotary piston or rotors **30** and **38** alternately occupy cross-over regions **20** and **22** each **180** degrees of rotation, closed intake-compression chambers designated **C1** and **C2** (FIG. **5**) and expansion-exhaust chambers **F1** and **F2** are effectively obtained within alternate halves of toroidal enclosures **V1** and **V2**, respectively.

Actually each of chambers C1 and C2 alternate between serving as intake and compression chambers with the other chamber simultaneously performing the opposite function. Similarly each of chambers F1 and F2 alternate between serving as expansion and exhaust chambers with the other chamber simultaneously performing the opposite function. Thus there is produced two power impulses per revolution of the like speed rotors. A fuel-air mixture is provided by carburetor 32 (FIG. 6) and fed through fuel intake duct 54 in housing 12 and openings 56 in hub 110 (FIGS. 2*g*, 4*a* and 4*b*) and distributed through integral valves and ports in a manner to be further described.

Following the termination of each expansion cycle, and during an exhaust cycle, expanding gases from one of the expansion-exhaust chambers, F1 or F2, is exhausted through one of exhaust vents 58 and 60 provided in cylindrical wall 61 of engine block 14 (FIG. 2*i*). The engine components will now be considered in greater detail.

INTAKE-COMPRESSION ROTARY INTEGRAL ASSEMBLY

Referring to FIGS. 2*f* and 3, rotary piston or rotor 30 in the general form of a half wheel is mounted integral within rim 64 and the whole assembly is adapted to rotate within support block 14 about a center axis 66 and about common engine center 18. Rim 64 includes peripheral edges 68 equipped with ring seats 70 adapted to accept tubular compression rings 72, shown installed in FIG. 6, and as disassembled in FIG. 6*a*. These rings provide a gas tight seal between rim 64 and cavity V1. Rotor 30 is essentially trapezoidal in cross-section, and extends aproximately 180° in radial length interior of and integral with the inner curved surface 74 of rim 64. Inner curved surface 74 of rim 64 and inner curved surface 76 of rotor 30 are sperically contoured to conform to the surfaces of concentric spheres about center 18. Sidewalls 78 and 79, which are perpendicular to inner and outer surfaces 76 and 74, are of a configuration formed between axially aligned, but oppositely positioned, spaced, frustrums of cones. The spacing is such that were the curves full cones the common center of the engine would be at a common apex of the cones. The cones thus described would have an included angle of 120° to 175°, typically 160°. The leading and trailing ends, or end surfaces 46 and 48 of rotor 30, as it rotates, are prismatic in form to provide optimum dynamic clearance of rotors 30 and 38 within cross-over regions 20 and 22. Adjacent to trailing end surface 48 of intake compression rotor 30 there is provided a narrow transverse duct 80 which extends through essentially the innermost one-half of the radial dimension of the rotor 30. This duct by passes residual exhaust gases to prevent exhausting of fuel mixture. The side wall surfaces 82 and 84 of rotor 30 are adapted to conform with and move tangentially against conical interior walls 86 and 88 of head assembly 16 and support block 14, respectively. The outer spherical surface 122 of power rotor 38 is adapted to conform with spherical interior wall 230. The inner spherical surface 76 of rotor 30 is adapted to conform with and move tangentially across the outer surface 113 of hub 110 of expansion-exhaust rotary assembly 36.

As a particular feature of this invention, rotational energy from spent escaping exhaust gases is used to apply additional torque to intake-compression rotary assembly 28. Lateral inlet holes 90 (FIG. 3) are drilled inward to intersect with radial holes 92 leading into inner body 94 of compression rotor 30. From there a series of tapered holes 96 drilled intermediate radial holes 92, interconnect the inner extremity 98 of same, and are inclined and open rearward with respect to the direction of rotation of intake-compression rotor 30. Thus exhaust gases are vented out of rim 64 via peripheral groove 100 in rim 64 and then out of enclosure 12 through opposing directive vents 58 and 60 of support block 14 (FIG. 2i). Air from the ambient atmosphere is allowed to flow into the engine through two short identical stationary ports 103 (FIGS. 1 and 2) (one is shown and the other is diametrically oppositely positioned) located adjacent and downstream from exhaust ports 332 and 330 in engine head assembly 16 and engine block 14, respectively. Port 103 supplies ambient air to each successive aperture 90 of rim 64 of intake compression rotor assembly 28 immediately following the period in which an aperture 90 is served by exhaust ports 332 and 330.

The exhaust velocity within aperture 90, radial hole 92, requires external energy to suddenly stop when it is no longer connected with exhaust port 330 or 332. This follows since the rapidly flowing exhaust gases within aperture 90 and radial hole 92 have inertia tending to continue flowing after it is suddenly disconnected from and no longer served by exhaust ports 332 and 330. This inertia of the exhaust gas flow creates a partial vacuum adjacent to port 103 resulting in flow from atmospheric pressure of air from outside the engine into each successive aperture 90 of rim 64 as it is served by port 103. Flow in a pipe cannot, of course, be instantaneously stopped when the supply is cut off. The negative pressure at a suddenly closed intake port is called a velocity head and results in a pressure head loss to the system unless, as in the subject case, an alternate source of fluid flow is provided. This velocity head draws fresh air in through ports 103 making it unnecessary for instantaneous stopping and head loss. The air so ingested cools the engine while it mixes with exhaust and increases the volume flowing through the turbine. Thus, exhaust flowing through aperture 90, radial hole 92, and tapered hole 96 is able to stop more gradually without the "insertion loss" inherent in impulse turbines.

Second, cool air follows exhaust into each rim aperture 90 in proportion to engine speed and engine power output to reduce engine temperature rise.

Third, flow through the turbine is made more uniform muffling exhaust noise.

Fourth, volume of gas within the turbine is increased as the ambient air expands.

Fifth, oxygen is supplied to more completely burn combustion by-products and reduce pollution.

Sixth, pressure and temperature of the exhaust released from exhaust vents 58 and 60 are more compatible with ambient air due to mixing within the turbine-muffler-exhaust manifold.

And, seventh, additional power is obtained from the engine from the additional (by-pass fan) gas volume and from not sustaining the deceleration entrance loss.

Pressure sealing rings 102 (FIG. 3), positioned adjacent leading and trailing ends 46 and 48 of intake-compression rotor 30, are configured and inclined to provide a biased engagement with linear seals 104

(FIG. 6*a*) which are abruptly encountered within cross-over reions **20** and **22** (FIG. 1). Intake-compression rotary assembly **28** is driven by means of ring gear **108** secured to and positioned around and integral with the inner periphery of rim **64**.

EXPANSION-EXHAUST ROTARY INTERGRAL ASSEMBLY

Expansion-exhaust rotor assembly **36** consists basically of rotary piston or rotor **38** and hub **110** to which it is secured. Rotor **38** is a semi-circular shell having a cross-section and radial length identical to that of rotary piston **30** of compressor rotary assembly **28**. Thus sidewalls **112** and **114** are identical with sidewalls **78** and **79** of rotor **30**. Likewise, there is included leading and trailing prismatic ends **50** and **52** and by-pass duct **120** adjacent to end **52** which in this case transfers fuel mixture between C1 and C2. Similarly, the outer spherical surface **122** of rotary piston **38** is spherical to conform with inner spherical surface **74** of rim **64** of intake-compression rotary assembly **28** against which it rotates. An interior shell portion **124** of rotary piston **38** includes integrally formed compressor blades **126** which constitute a second stage **134** of a two-stage centrifugal compressor configuration. The first stage **132** of the compressor configuration is rotatably supported within hub **110** by main shaft **128** and is driven in contra-rotation to that of main shaft **128** by gear **130** interconnecting with gear assembly **44** (FIGS. 2*c* and 6). As shown in FIGS. 4*c* and 4*d*, compressor stage **132** is of a centrifugal type in which intake is in through vanes **132***a* and output is out through slots **136** between vanes **132***b*. Flow is then into annular cavity region **140** of rotary piston **38** is closed on one side **142** by annular disc **144**. Cavity region **140** is between counter rotating vanes **132***b* of first compressor stage **132** and vanes **126** of second stage compressor **134** to create a region of increased pressure in this cavity region. Annular disc **144** includes a splined central opening **146** adapted to accept a mating spline **148** on main shaft **128** (FIG. 2*e*).

FUEL INTAKE

A fuel-air mixture from carburetor **32** flows through duct **54** in the planar wall **232** of hub support **206** and into the interior of hub **110** which functions as an intake manifold, entry being through a plurality of radially spaced inlet openings **56** in support disc **144**. The mixture is compressed in hub **110** and then fed through elongated slots **136** of compressor stage **132** to region **140** where the mixture meets the counter rotating blades **126** of second stage compressor **134** and the thus pressurized mixture in this region **140** is fed through a plurality of radially spaced outlet apertures **154** extending axially through circular plane opposing end surfaces **156** and **157** of hub **110** into alternate intake-compression chambers C1 and C2 ahead of compression surface **46** and behind intake surface **48**. Peripheral ring seats **160** (extensions of surfaces **115** and **117**) which are formed about end surface **156** and **157** of hub **110** are adapted to engage tubular rings **162** which provide a seal between hub **110** and lateral conical inner surfaces **164** and **166** of toroidal enclosure V2.

SYNCHRONIZATION OF INTAKE-COMPRESSION AND EXPANSION-EXHAUST ROTOR ASSEMBLIES

Synchronizing gear assembly **44** shown in FIG. 2*c* connects and thus provides synchronized rotation between intake-compression rotor assembly **28** and expansion-exhaust rotor assembly **36**. It Includes a large gear **168** near one end of shaft **170** and a small gear **172** on the opposite end of shaft **170**. As shown in FIG. 6, small gear **172** engages ring gear **174** of hub **110** of expansion-exhaust rotor assembly, the latter **172** drives gear **168** of gear assembly **44** and gear **168** of gear assembly **44** in turn drives ring gear **108** of intake-compression rotary assembly **28**. Equal gear ratios between gears **168** and **172** and gears **108** and **174**, respectively, assure that rotary pistons **30** and **38** turn in synchronism. Shaft **170** is rotatably supported at an inner end **176**, near gear **172**, by bearing **178** mounted to central support plate assembly **180** and at the opposite, outer end, by bearing **182** centrally secured to bearing support plate **184** of gear cover **186**.

GEAR COVER

Gear cover **186** shown in FIG. 2*a* comprises a semi-cylindrical member **188** having lower edges **190** contoured to mate with upper surface **192** of engine head cover **16** and which is provided with a mounting flange **194** adapted to be attached to lateral wall **234** of cavity V2 of engine head cover **16**, through mounting holes **192**.

CENTRAL SUPPORT PLATE ASSEMBLY

Central support plate assembly **180** shown in FIG. 2*h* includes a lower region **202** adapted to seal within mounting slot **204** provided in central hub support **206**, being attached by bolts **208** (FIG. 6) to sidewall **234** of cavity V2 through mounting holes **211**. Circular upper region **212** is adapted to be secured to side wall **234** of cavity V2 through mounting holes **216**. Centrally mounted main shaft support bearing **218** (FIG. 6) is dimensioned to support inner end **220** of main shaft **128**, being also axially supported by a second inner bearing **222** adjacent shoulder **223** and a nut **224** threaded to inner end **220** of shaft **128**, being rotatably journalled near outer end **226** by bearing **228**.

INTERIOR OF ASSEMBLED ENGINE

As has been heretofore described, the curved engaging surfaces of the engine are spherical and concentric, having a common center **18**. The interior surface **74** of rim **64** (FIG. 3) and outer surface **122** of rotary piston **38** (FIG. 4*a*) are mating spherical surfaces having the same radius and the same center and the outer surface **113** of hub **110** (FIG. 4*a*) and the inner surface **76** of rotary piston **30** (FIG. 2*f*) are mating spherical surfaces and have the same center. Rotary pistons **30** and **38** (FIGS. 3 and 4*a*) have opposed lateral surfaces **82** and **84** and **115** and **117**, respectively, which are those which may be said to be formed between spaced frustrums of cones positioned on the same axis with the smaller ends of the frustrums of the cones adjacent, but spaced. The inner sidewalls of the interior of the engine enclosure, of course, having conforming closing surfaces. Thus the interior lateral surfaces of the raised portion of engine head cover **16** and the interior of the lateral walls of the inner portion of support block **14** conform to these frustrums of cones comprising lateral wall surfaces **82** and **84** of rotor **30.** Referring to FIG. **6,** and initially to cavity V2, those portions of fixed spherical outer peripheral wall **230** and conical lateral walls **232** and **243,** which are integral with engine head **16** and engine block **14,** are dimensioned and contoured to the rotary piston **38** of expansion-exhaust rotary assembly **36.** Those portions of outer wall of cavity V2 within cross-over areas **20** and **22** are enclosed by inner spherical surfaces **74** of rim **64** of intake-compression rotary assembly **28.** Outer spherical surface **113** of central hub **110** forms the inner closing wall of cavity V2. The outer peripheral closing wall of cavity V1 comprises inner surface **74** of rim **64.** Interior conical surfaces **236** and **238** of engine head **16** and engine block **14,** respectively, are positioned to rotatably accept the complementary surfaces **82** and **84** of rotary piston **30** of intake-compressor rotary assembly **36.** The inner sealing wall of cavity V1 is formed by fixed spherical surfaces **240** and **242** of central annular hub support **206,** complemented by common spherical surface **113** of central hub **110.**

SEALING RINGS

The stationary internal sealing assembly **244** of engine **10** is shown in perspective in FIG. *6a*, being disassembled from engine **10** but having seals placed in the same relative positions they assume when assembled (FIGS. **1, 6** and **7**). The multiple seals are formed of expansible tube, being essentially rectangular in cross section. Outwardly disposed compression rings **72,** formed into continuous circular tubes, are adapted to sealably mate with peripheral ring seats **70** (FIG. **3**) of support rim **64,** being securely supported by aligned annular seats **246** and **248** (FIG. **6**), formed in lateral walls **236** and **238,** respectively, of toroidal enclosure V1.

Inwardly disposed compression rings **162** likewise formed into continuous circular tubes, are adapted to sealably mate with peripheral ring seats **160** (FIGS. *4a* and *4b*) of hub **110** being supported by aligned annular seats **250** and **252** formed in lateral walls **234** and **232,** respectively, of toroidal enclosure V2 (FIG. **6**). Sets **254** and **255** of linear seals **104,** each consisting of four spaced linear seals, radially interconnecting between pairs of circular seals **162** and **172** are are supported by linear seats **256** formed at the junction of lateral walls **234** and **232** of toroidal enclosure V2 and lateral walls **236** and **238** of toroidal enclosure **12** (FIG. **5**). Linear seals **254** and **255** are adapted to guide leading surfaces **50** and **46** of rotors **38** and **30,** respectively, within cross-overs **20** and **22.**

COMBUSTION

Identical pre-combustion chambers **42** and **40,** phase or position displaced 180°, are physically illustrated in FIGS. *2b* and *2i* and diagrammatically illustrated in FIG. **7.** Referring first to one combustion chamber **40,** it will be noted that it includes an inlet port **258** which is generally closable by lateral surface **84** of intake-compression rotor **30** for approximately **45** percent of each revolution of the engine. Such blocking is initiated by the arrival of a compression surface **46** of intake-compression rotor **30** at inlet port **258** and is unblocked by the arrival of intake surface **48** of this rotor. The opposite or complementary inlet port **260** of opposite pre-combustion chamber **42** is alternately blocked and unblocked by opposite lateral surface **82** of intake-compression rotor **30** in the same fashion. Check valves **262** and **264,** respectively, also close pre-combustion chamber inlet ports **258** and **260** and are biased to a closed position by springs **259.** Thus, the check valves back up the sealing provided by rotor **30** and thus double seal the inlet ports **258** and **260** to prevent leakage back through the inlet ports.

The outlets from pre-combustion chambers **40** and **42** are blocked during presence of lateral surfaces **117** and **115,** respectively, of power rotor **38** for approximately **45** percent of each revolution of the engine. Such blocking is initiated by the arrival of an exhaust surface **50** of power rotor at outlet port **265,** of one combustion chamber **40** and is terminated by the arrival of expansion surface **52** at outlet port **265,** such being the trailing surface of hub mounted rotor **38.**

The opposite or complementary outlet port **267** of pre-combustion chamber **42** is alternately blocked and unblocked by power rotor **38** in the same fashion.

As a particular feature of this invention each of the outlet ports **265** and **267** is additionally sealed by means of pressure operated valve system **266** to assist in preventing the passage or leakage of gases except when an outlet port is opened by power rotor **38** to admit expanding gases into an expansion mode chamber of cavity V2 behind the expansion surface **52** of power rotor **38.** The system includes two differentially operated valve assemblies **268** and **270,** which act essentially coincident with power rotor surfaces **117** and **115,** respectively, to back up and positively, double seal, the outlet port of pre-combustion chambers **40** and **42.** Like components of each valve assembly carry the same reference number with added suffixes a and b. A general reference to a component without the suffix shall apply to a component of either valve assembly.

Each of valve assemblies **268** and **270** includes a rotatable outlet valve **272,** mounted on a pivot **274** and biased to an open position by spring **276,** spring **276** applying counter-clockwise force to outlet valve **272.** The high pressure surface **278** of each outlet valve **272** is exposed to the interior of a pre-combustion chamber in which detonation or firing occurs. Low pressure surface **284** of each outlet valve **272** faces and seals an outlet port (outlet port **265** or **267**) of one of the pre-combustion chambers **40** and **42** in its closed mode and slides into recess **282** in its, normally open, mode. Back surface **280** of each outlet valve is exposed, within fluid chamber **286** of a valve assembly **268** and **270,** to a moving stream of hydraulic fluid. This stream of fluid is supplied by rotary pump **288** which draws fluid from coupling tubes **290** and **292,** differentially connecting fluid chamber outlet **294*a*** of valve assembly **268** to fluid chamber inlet **296*b*** of valve assembly **270** and fluid chamber outlet **294*b*** of valve assembly **270** to fluid chamber inlet **296*a*** of valve assembly **268.** It will be observed that inlets **296*a*** and **296*b*** from tubes **290** and **292** are particularly positioned upstream of flow and that the pump outlets **298** and **300** are in the form of orifices downstream of flow. Normally, that is in the absence of the occurrence of a detonation in one of the pre-combustion chambers, an outlet valve would be in a normally open mode and fluid flow would be along the path of the arrows and fluid flow between tubes **290** and **292** is such that pumping is continuous despite momentary transients in first one then the other tube. As shown, pump **288**, itself, is out of the main circuit of the flow and thus isolated from pressure shock transients which occur with a detonation.

Each of valve assemblies **268** and **270** includes a pilot valve, valves **302***a* and **302***b*, each of which operates to open and close an inlet to fluid chamber **286** of each pilot valve. The pilot valves are each normally biased open counterclockwise, by spring **304**, and thus normally permit the fluid flow just described. An example of a complete spring for **304***a* is shown in FIG. 7*b*. It is pretzel-shaped and, as shown, is attached by screw **305***a* to the case or housing **12** of the engine. Spring **304***b* is of the same configuration. Upon the detonation in one of the pre-combustion chambers, a rotary piston **306** would be moved downward to close a pilot valve **302** and thus momentarily interrupt fluid flow, with the effect to be described.

The operation of pressure operated valve system **266** is as follows. Initially, the engine is started with outlet valves **272** and pilot valves **304** held open by their associated springs. Pump **288** forces a continuous flow around the unobstructed closed circuit. Assuming that a first detonation occurs in pre-combustion chamber **42**, pilot valve piston **306***b* of pilot valve **302***b* is forced downward causing pressure to increase in the upper left end portion **308** of tube **292** and low pressure to occur downstream in tube **290**. Outlet valve **272***b* would thus not be affected because the operating pressure on it would be reduced and thus spring **276***b* would maintain this valve open. Upstream of liquid pilot valve **302***b*, there would occur an abrupt or instantaneous increase in pressure causing a tube **292** to stretch somewhat and to start a compression (water hammer effect) wave back past pump orifice **300** to back surface **280***a* of outlet valve **272***a* causing it to overcome return spring **276***a* and thus cause outlet valve **272***a* to close. This is facilitated since there is a lower pressure within pre-combustion chamber **40** which would thus not oppose the increased fluid pressure applied to outlet valve **272***a*. The energy in the compression wave and diverted liquid from the moving stream is absorbed in the action of closing outlet valve **272***a* coincident with the arrival at outlet port **265** of exhaust surface **50** and lateral surface **117** of power rotor **38** and therefore coincident with the completion of purge and beginning of a compression phase through check valve **262** into pre-combustion chamber **40**.

With the completion of the just described compression phase, the closing of inlet check valve **262**, alternation of the adjacent intersection **20** begins. During such alternation of intersection (before an appropriate advance spark) and the arrival of expansion surface **52** at outlet port **265**, spark plug **312***a* detonates the compressed charge in the other pre-combustion chamber **40**. Pressure from this detonation activates adjacent liquid pilot valve **306***a* abruptly stopping liquid flow in tube **290**. Just as before, a vacuum occurs downstream, this time reducing pressure on back surface **280***a* of outlet valve **272***a* augmenting opening of this valve under the pressure on front surface **278***a* from the expanding charge in pre-combustion chamber **40**. Coincident with the arrival of expansion surface **52** of power rotor **38** at outlet port **265**, valve **272***a* opens and thus double opens outlet port **265** to permit expansion of the exploding charge out into the volume behind expansion surface **52**. Upstream, as before, compression occurs and the abruptly stopped liquid compresses, tube **290** stretches as necessary, and a compression wave proceeds at approximately 4700 feet per second to the back surface **280***b* of the outlet valve **272***b*. The energy of this wave and liquid flow diverted thereby is absorbed in the closing of outlet valve **272***b* locking outlet port **267** coincident with the arrival of exhaust surface **50** which double seals outlet port **267** at the beginning of the subsequent phase into purged pre-combustion chamber **42**.

Thus the closed dynamic circuit of moving fluid operates in a complementary fashion to differentially operate outlet valves **272***a* and **272***b* by means of transmitting a rapidly moving compressional (water hammer) wave, almost simultaneously opening and closing outlet valves **272** as required. The detonation force transmitted by way of a liquid pilot valve, initiates opening of an adjacent outlet port and initiates closing of the other outlet port coincident with the respective arrival of expansion surface **52** and exhaust surface **50** of power rotor **38**. Power for operating pump **288** is obtained by means of a rotary connection to main shaft **128** of the engine by means not shown. Conventional distributor **227** (FIG. **1**) driven by shaft **128** powers spark plugs **312***a* and **312***b* (FIG. **7**).

Lubrication is provided by conventional means with distribution aided by centrifugal force from a low pressure sump in gear housing **186**. Return flow is through stationary seals **244** (FIG. **6***a*).

GENERAL DESCRIPTION OF FLOW THROUGH ENGINE

A fuel mixture under pressure is gated through outlet apertures **154** of central hub **110**, acting as intake manifold, into alternate compression chambers **C1** and **C2** through diametrically opposed inlet ports **316** and **318** (FIG. **2***a*), formed in central hub support **206** of engine block **14**.

Inlet port **316** has axial input opening **320** (FIGS. **8***a*–**8***l*) oriented and dimensioned to communicate with axial apertures **154** in lateral wall **156** of central hub **110** and has radial outlet opening **322** entering compression chamber **C2** through outer spherical surface **240** of central hub support **206**. The combination of inlet opening **320**, outlet opening **322** and passageway there between, comprising a first stationary porting channel, and inlet opening **324**, outlet opening **326**, and passageway there between, comprising a second stationary porting channel.

Diametrically opposed inlet port **318** is similarly formed and oriented to communicate in like manner with axial apertures **154** in opposite lateral wall **157** of central hub **110** and with compression chamber **C1** through inlet and outlet openings **324** and **326**, respectively, during the alternate 180° rotational interval. As compression chamber **C2** is being charged with combustible mixture, combustible mixture from a previous intake cycle is compressed in alternate chamber **C1**, a portion being forced by compression surface **46** through check valve **262** (FIG. **7**) into pre-combustion chamber **40**. Chamber **40** having radially formed inlet opening **258** in lateral wall **88** of compression chamber **C1**, communicates with firing chamber **F2** through similarly configured outlet opening **265** in lateral wall **164** of firing chamber **F2**.

Openings **258** and **265** of pre-combustion chamber **40** are sealably controlled by lateral wall surfaces **84** and **117** of compression rotor **30** and power rotor **38**, respectively. When compression, or leading surface **46** of compression rotor **30** passes inlet opening **258** of chamber **40,** now charged with fuel under pressure, the residual compressed fuel is transferred into compression chamber **C2** as follows.

As leading surface **46** of compression rotor **30** and trailing surface **52** of power rotor **38** enter intersection **20** (FIG. **8***d*), transverse fuel bypass duct **120** of power rotor **38** interconnects minimum volume region of chamber **C1** with alternate chambers **C2** thus allowing excess compressed fuel to flow into **C2**, partly compressing charge within **C2**.

When the leading surface **46** of compression rotor **30** enters compression chamber **C2** (FIG. **8***g*) the functions of chambers **C1** and **C2** are interchanged during the next 180° interval and compression chamber **C1** is charged with fuel through opposite inlet port **318** (FIG. **2***i*) while fuel from the previously described intake cycle is compressed in chamber **C2**. A maximum portion of this fuel is forced into second pre-combustion chamber **42,** having inlet opening **260** in lateral wall **236** of chamber **C2** and which communicates with firing chamber **F1** through outlet opening **267** formed in lateral wall **234.** As the leading and trailing surfaces **46** and **52** of compression and power rotors **30** and **38,** respectively intersect with opposite intersection **22,** excess fuel under pressure is again transferred, this time into opposing chamber **C1** through bypass duct **120** of power rotor **38** (FIG. **8***j*).

During this same interval, exhaust bypass duct **80** of intake-compression rotor **30** (FIGS. **8***d* and **8***j*) interconnects **F1** and **F2** to equalize exhaust pressures preventing the exhaust of combustible mixture from chambers **C1** and **C2** during alternation-of-intersections intervals.

Spent gases from the expansion cycles are scavenged by leading exhaust surface **50** of power rotor **38** and are routed into exhaust turbine elements **96** through exhaust ports **328** and **330.** Exhaust port **328** having radial inlet slot **332** formed in outer wall **230,** within minimum volume region **334,** of firing chamber **F1** interconnects with tangential outlet slot **336** positional to communicate with inlet apertures **90** of support rim **64** of intake-compression rotary assembly **28.** Opposite exhaust port **330** similarly placed and formed in firing chamber **F2** has outlet opening **338** adapted to communicate with opposing inlet apertures **90** of support rim **64.**

OPERATION

With particular reference to FIGS. **8***a* through **8***l* there is shown, in schematic form, the completion of four phases of engine operation as they occur during alternate 180° rotational intervals of engine, namely expansion, exhaust, intake and compression. FIG. **9** illustrates the time relationship between events in different parts of the engine. In the schematic drawings, those elements not vital to an understanding of the above mentioned phases of operation have been omitted. In order to facilitate cross reference between the various figures heretofore described, like elements of the engine represented by FIGS. **8***a* through **8***l* have been similarly oriented and assigned like designations.

Upon the rotation of engine **10** as by an electrical starter, not shown, an air-fuel mixture from carburetor **32** is drawn in through fuel inlet duct **54** into support hub **110** (FIG. **6**) of power rotor **38,** and distributed to compression chambers **C1** and **C2,** being gated through outlet apertures **154** communicating with intake ports **316** and **318** (FIG. **2***i*). For clarity, only the final outlet openings **322** and **326** of intake ports **316** and **318** respectively (FIG. **2***i*) leading directly into compression chambers **C1** and **C2,** are shown in the schematic drawings **8***a* and **8***l*.

Further, only the inlet openings **332** and **331** (FIG. **2**) of exhaust ports **328** and **330** of respective firing chambers **F1** and **F2** are shown. Arrows indicate direction of engine rotation and gas flow. The sequence of events depicted in FIGS. **8***a* through **8***l* is initiated when compression rotor **30** and power rotor **38** are in the respective positions as shown in FIG. **8***a*. As the sequence progresses (FIG. **8***a*), crossover **20** is sealed by power rotor **38** and crossover **22** is sealed by compression rotor **30** obtaining compression chamber **C1,** and closed firing chamber **F1** within enclosure **12.** As shown in FIG. **8***a*, burning combustibles, within pre-combustion chamber **42,** having been ignited by spark plug **312***b*, expand into minimum volume region of firing chamber **F1** applying a tangential force to trailing surface **52** of power rotor **38.** For purposes of engine timing, this angular position is chosen as 0° (FIG. **9**). As this impulse is applied, compression rotor **30** and power rotor **38** continue to rotate in synchronism in the direction indicated, and the first four phases of operation of engine **10** occur during the first 180° of rotation.

Referring to compression chambers **C1** and **C2,** as the trailing end **48** of compression rotor **30** recedes from intersection **20,** outlet opening **322** of intake port **316** (FIG. **2***i*) previously closed by inner surface **76** of rotor **30** is opened, admitting a fuel mixture into compression chamber **C2** as the swept volume increases. As is shown in FIG. **9,** intake in **C2** actually begins at zero degrees and concludes at **132** degrees.

Opposite fuel outlet opening **326** of inlet port **318** has been closed by leading inner surface **76** of rotor **30** and pre-combustion chamber **40** is purged of dead gases from a previous expansion cycle. Purge cycle ends as lateral surface **117** of power rotor **38** seals outlet opening **265** (FIG. **8***b*), obtaining closed compression chamber **C1.** Thus compression occurs in **C1** from 23 degrees to 132° (FIG. **9**). As the volume within chamber **C1** decreases, fuel from a previous intake cycle is compressed by leading surface **46** of compression rotor **30** until rotor **30** reaches the position shown in FIG. **8***d*.

With respect to events occurring within firing chambers **F1** and **F2** (FIGS. **8***a*–**8***f*), expansion continues in firing chamber **F1** pushing trailing surface **52** of power rotor **38** to the position shown in FIG. **8***e* where exhaust inlet opening **332** is open at 173° (FIGS. **8***f* and **9**). Pneumatic pre-compression of subsequent compression phase is achieved using a measure of residual expansion during alternation-of-intersections.

Spent gases within firing chamber **F2** are scavenged by leading surface **50** of power rotor **38,** being expelled outward through exhaust opening **331** (FIGS. **8***a*–**8***d*). The largest possible fraction of combustible mixture, stored for the subsequent explosion phase, is now compressed through check valve **262** (FIGS. **8***c* and **9**) into precombustion chamber **40,** the remaining excess compressed mixture being contained within minimum volume region of compression chamber **C1.** As shown in FIG. **8***d*, when trailing end or expansion surface **52** of power rotor **38** enters intersection **20,** intersecting compression rotor 30, fuel bypass duct 120 of power rotor 38 interconnects compression chambers C1 and C2 bypassing pre-compressed fuel mixture being retained within compression chamber C1 into compression chamber C2, at 147 degrees (FIG. 9), adding to the charge from intake stroke in chamber C2 in preparation for the subsequent compression cycle in C2. At the same time, exhaust bypass duct 80 of compression rotor 38 interconnects firing chambers F1 and F2 equalizing exhaust pressure between the two and preventing exhaust of fuel mixture.

The outer surface 122 (FIG. 2*g*) of power rotor 38 has opened exhaust opening 332 (FIG. 8*d*) and is closing opposite exhaust opening 331. Although exhaust inlet opening 332 is unsealed, exhaust port 328 is closed by inner peripheral wall 91 of support rim 64 (FIG. 2*f*) being in sealable contact with outlet opening 336 (FIG. 2*b*), thus F1 is still in sealed condition. During the following interval (FIG. 8*e*) in which power rotor 38 and compression rotor 30 are in the process of alternating occupancy of intersections 20 and 22, simultaneously, residual pressure within firing chamber F1 is released, by way of intersections 20 and 22 into compression chamber C2 to further compress the entire charge in preparation for a subsequent compression stroke. As compression and power rotors 30 and 38, respectively, reach positions shown in FIG. 8*f*, crossover 22 is being sealed by power rotor 38 and crossover 20 is being sealed by compression rotor 30, to obtain compression chamber C2 and closed firing chamber F2 as shown in FIG. 8*g*. Thus, as shown in FIG. 9 the first four phases of operation are completed, at 180°, ignition having occurred in pre-combustion chamber 40, during previous 35°, depending upon spark advance (FIG. 9).

The beginning of a like sequence of events occurring during the following 180° interval is depicted in FIG. 8*g*, wherein intake now occurs in compression chamber C1, through outlet opening 326, as opposite outlet opening 320 is closed by inner surface 76 of compression rotor 30. Outlet opening 265 of precombustion chamber 40 opens admitting burning combustibles, having been ignited by timed spark to spark plug 312*a*, to enter firing chamber F2, also igniting compressed charge already in F2. This initiates the second expansion cycle within firing chamber F2 at 180° (FIG. 9), such as occurred at 0° within firing chamber F1 (FIG. 8*a*), wherein a tangential force is again applied to trailing surface 52 of power rotor 38. Leading surface 50 of power rotor 38 scavenges spent gases from the previous expansion cycle pushing them out exhaust port 332 now unsealed. Thus exhaust begins in F1 at 173° and ends at 320° as shown in FIG. 9.

Compression rotor 30 advances into compression chamber C2, at 180° (FIG. 8*g*), and precombustion chamber 42 is purged of spent gases from the previous explosion cycle. The purge cycle ends as power rotor 38 advances to close outlet opening 267 of precombustion chamber 42 (FIG. 8*h*). As the volume within chamber C2 decreases, fuel from the previous intake cycle is fully compressed through check valve 264 into precombustion chamber 42 as compression rotor 30 reaches the position shown in FIG. 8*j*. As is shown in FIG. 8*j*, excess precompressed fuel is again transferred, in this case from minimum volume region of compression chamber C2 through fuel bypass duct 120 of power rotor 38 into compression chamber C1.

Exhaust bypass duct 80 interconnects firing chambers F1 and F2, equalizing exhaust pressure between the two at 327° (FIG. 8*j*). As rotors 30 and 38 again alternate occupancy of intersections 20 and 22, as shown in FIG. 8*k*, fuel in compression chamber C1 is further tamped, 340° in FIG. 9. In FIG. 8*l*, ignition having occurred in precombustion chamber 42, minimum volume of F1 is filling up from chamber C1 prior to seal off by compression surface 46 for a subsequent expansion phase.

CARBURETION

FIGS. 1, 7 and 7A illustrate a particular system of supplying an air-fuel mixture to the engine. As shown, a carburetor 317 is associated with and supplies a fuel-air mixture to each of intake ports 317 and 318 (FIG. 2*i*). Fuel is fed to each of carburetors 316 through a fuel line 352 (FIG. 7) and passes into throat or restriction 320 of the carburetor through fuel jets 341. Air is controllably throttled into the carburetor by means of rotary valve 342. Rotary valve 342 (shown open) is controllably operated by means of shaft 349 which in turn is operated by linkage arm 350 coupled thereto by means (shown closed) of a lever arm 354. Shaft 349 which is coupled to linkage 350 through arm 353 control the second of the carburetors, not shown, which supplies a fuel into the engine through port 318. By this form of integrated carburetor, as shown, volumemetric efficiency and control response is substantially improved.

It is to be noted that one, vaporized fuel is absent from the gas flowing in through two centrifugal compressor stages and is introduced in the turbulent flow through respective intake ports adjacent to respective intake chamber C1 or C2.

Second, heat of vaporization is supplied from the compressed air flowing through intake port cooling intake mixture as it enters intake chamber C1 and C2 increasing the density and cooling the engine in the process.

Third, all intake air passes through low pressure engine oil sump eliminating the need for ports 54 in support block and ports 56 in back wall 157 of hub 110 of power rotor assembly 36.

An air cleaner and choke may be attached directly to gear cover 186 and inlet to centrifugal compressor 132 reversed so that cool inlet air may pass directly through the center of the engine, cooling the gears and bearings.

SUMMARY OF ACCOMPLISHMENTS

One major advantage inherent in the engine of this invention is the relatively constant angular velocity of the major moving parts.

A second major advantage is that there occurs purely tangential virtual displacement of gas interface surfaces.

Third, there is achieved a relatively constant air intake and exhaust.

Further, there is provided an inside to outside cooling gas flow path.

While the invention has been particularly described as providing a new and improved rotary internal combustion engine, its structure also will perform the function of fluid energy conversion in general such as provided by pumps, compressors, and external as well as internal combustion engines.

What is claimed is:

1. A rotary power translation machine comprising:

first and second toroidal cavities intersecting in first and second common regions and said cavities being relatively inclined about a common center at an included angle of 50° to 90°;

a first rotor assembly comprising an annular rim and a half annular rotor interior of and integral with said annular rim, and said annular rotor being positioned, configured, and having a mass distribution for balanced sealable rotation within said first toroidal cavity;

a second rotor assembly comprising a hub and a second half annular rotor mounted about and integral with said hub, the interior of which hub comprises an intake manifold and said hub being positioned, configured, and having a mass distribution for balanced sealable rotation within said second toroidal cavity;

intake porting means comprising:

an opening in said second cavity adapted to admit fluid into said hub,

first and second stationary porting channels having outlets into first and second angularly opposite regions of said first cavity, respectively,

a first set of ports in said hub positioned to cooperatively engage the inlet of said first stationary porting channel during a first selectively portion of the rotation of said second half angular rotor, and

a second set of ports in said hub positioned to cooperatively engage the inlet of said second stationary porting channel during a second selected portion of the rotation of said second half annular rotor,

whereby fluid is alternately supplied to said angularly opposite regions of said first cavity;

first and second cavity coupling chambers, said first cavity coupling chamber being coupled between said cavities across and thus by-passing, for a relatively short distance, said first intersecting region, said second cavity coupling chamber being coupled between said cavities across and thus by-passing, for a relatively short distance, said second intersecting region;

drive means interconnecting said first and second rotor assemblies for synchronous cross rotation of said annular rotors; and

shaft means coupled to at least one of said rotor assemblies for providing shaft couplings to said rotary power translation machine.

2. A rotary power translation machine as set forth in claim 1 wherein the trailing edge of each said half annular rotor includes a transverse slot, which said slot in said first half annular rotor by-passes residual fluid in an otherwise large, sealed cavity region of said second cavity to the smaller cavity region of that cavity and said slot in said second half annular rotor by-passes residual gases in an otherwise sealed small cavity region of said first cavity to the then larger cavity region of said first cavity, whereby otherwise trapped gases are disposed of by transfer to a subsequent cycle of operation.

3. A rotary power translation machine as set forth in claim 1 further comprising:

first sealing means comprising a pair of spaced expandible seals circularly configured and adapted to seal between said first cavity and opposite edges of the joinder between said first half annular rotor portion and the annular rim portion of said first rotor assembly;

second sealing means comprising a pair of spaced stationary expansible seals circularly configured and adapted to seal between said second cavity and opposite edges of said second half annular rotor where said second half annular rotor adjoins the hub portion of said second rotor assembly; and

third sealing means comprising expansible seal members extending between said first seal means and said second seal means on each cavity wall along each intersecting cavity wall adjacent each intersection between said first cavity and said second cavity.

4. A rotary power translation machine as set forth in claim 3 further comprising fourth sealing means comprising rotating expansible rotor seals extending generally radially on the exposed side region adjacent each end of each half annular rotor, on the inner peripheral surface of said first rotor, and on the outer peripheral surface of said second rotor.

5. A rotary power translation machine as set forth in claim 4 wherein said fourth sealing sealing means includes in each said region at least two said expansible seals and said machine further comprises means for supplying a lubricant to the region between at least two of said seals and said first, second, and third sealing means comprise passage-ways, whereby lubricant is centrifically distributed outward between seals by rotation of said half annular rotors from the center region of said means and distributed and returned to the center region of said machine through said first, second, and third said sealing means.

6. A rotary power translation machine as set forth in claim 1 further comprising first and second exhaust transfer means, positioned 180° apart, each comprising a stationary porting channel having an inlet port adapted to receive exhaust fluid from a selected region of said second cavity by being uncovered by said second rotor and an outlet port adapted to communicate with selected openings into the interior of the rim of said first rotor assembly from which they are exhausted through first cavity wall.

7. A rotary power translation machine as set forth in claim 1 wherein said second rotor assembly includes compression means for receiving said fluid into said hub and compressing said fluid and supplying it under pressure through said first and second stationary porting channel and said first and second sets of ports in said hub to said annular opposite regions of said first cavity.

8. A rotary power translation machine as set forth in claim 6 wherein the interior of said second rotor assembly includes a plurality of peripherally directed, but canted, passageways whereby additional effective fluid pressure is created.

9. A rotary power translation machine as set forth in claim 1 further comprising means for providing a fuel-air mixture as said fluid to said first cavity.

10. A rotary power translation machine as set forth in claim 9 wherein said means for providing said fuel-air mixture includes a throttle valve in each of said porting channels and means for supplying fuel into said last named channels whereby carburetion occurs and air and fuel are mixed in said channels and the speed

of said engine is controlled by the operation of said throttle valves.

11. A rotary power translation machine as set forth in claim **9** wherein said first and second channels connecting said cavities comprise pre-combustion chambers and said engine further comprises ignition means coupled to each said pre-combustion chamber for igniting a fuel-air mixture received from said first cavity.

12. A rotary power translation machine as set forth in claim **11** further comprising check valve means at the entrance of each said pre-combustion chamber from said first cavity for permitting fluid flow through the entrance to the pre-combustion chamber from said first cavity and assists in inhibiting flow out of the entrance of said combustion chamber into said first cavity, whereby the outlet valving of said first cavity is made redundant.

13. A rotary power translation machine as set forth in claim **11** further comprising:

a first normally open valve means interconnecting the exit of said first pre-combustion chamber to said second cavity and a second normally open valve means interconnecting the exit of said second pre-combustion chamber to said second cavity; and

valve operating means responsive to detonation in said first pre-combustion chamber for momentarily closing said second valve means and responsive to detonation in said second combustion chamber for momentarily closing said first valve means, whereby the intake valving of said second cavity is made redundant.

14. A rotary power translation machine as set forth in claim **11** wherein the exit of each of said pre-combustion chambers includes sidewalls conforming to radial planes intersecting at said common center.

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