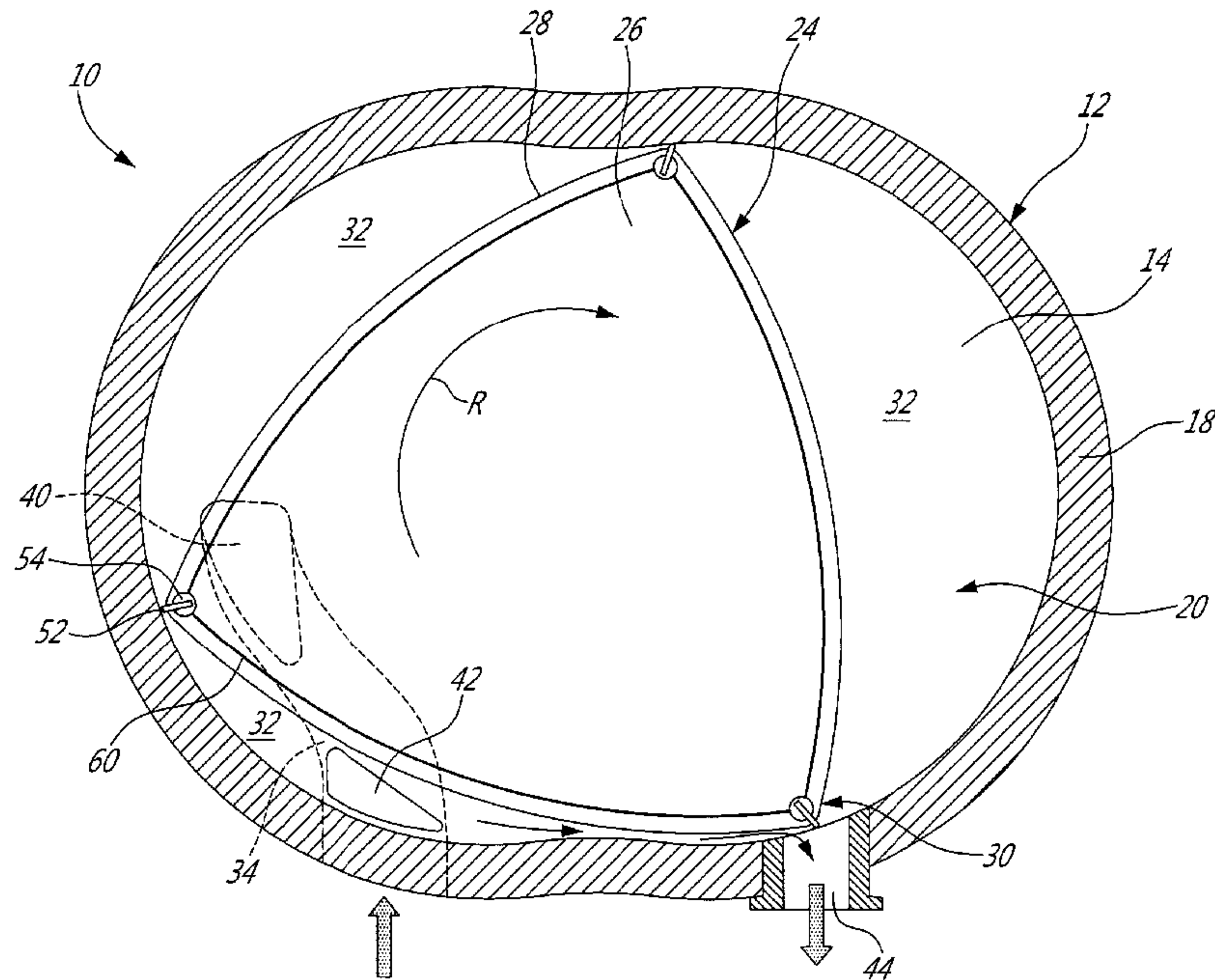




(22) Date de dépôt/Filing Date: 2012/07/06
(41) Mise à la disp. pub./Open to Public Insp.: 2013/01/28
(45) Date de délivrance/Issue Date: 2019/05/21
(30) Priorités/Priorities: 2011/07/28 (US61/512550);
2011/10/12 (US13/271855)

(51) Cl.Int./Int.Cl. *F01C 21/18* (2006.01),
F01C 21/10 (2006.01), *F02B 53/02* (2006.01),
F02B 53/04 (2006.01)
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(54) Titre : MOTEUR ROTATIF A COMBUSTION INTERNE AVEC VIDANGE DES GAZ D'ECHAPPEMENT
(54) Title: ROTARY INTERNAL COMBUSTION ENGINE WITH EXHAUST PURGE



(57) **Abrégé/Abstract:**

In one aspect, described is a rotary engine having a purge port located rearwardly of the inlet port and forwardly of the exhaust port along a direction of the revolutions of the rotor, the purge port being in communication with the exhaust port through each of the chambers along a respective portion of each revolution, and the inlet and outlet ports being relatively located such that a volumetric compression ratio of the engine is lower than a volumetric expansion ratio of the engine.

ABSTRACT

In one aspect, described is a rotary engine having a purge port located rearwardly of the inlet port and forwardly of the exhaust port along a direction of the revolutions of the rotor, the purge port being in communication with the exhaust port through each of the chambers along a respective portion of each revolution, and the inlet and outlet ports being relatively located such that a volumetric compression ratio of the engine is lower than a volumetric expansion ratio of the engine.

ROTARY INTERNAL COMBUSTION ENGINE WITH EXHAUST PURGE

TECHNICAL FIELD

5 The application relates generally to an internal combustion engine using a rotary design to convert pressure into a rotating motion, more particularly, to the ports for such an engine and a method of operating such an engine.

BACKGROUND OF THE ART

10 Rotary engines, such as for example Wankel engines, use the eccentric rotation of a piston to convert pressure into a rotating motion, instead of using reciprocating pistons. In these engines, the rotor includes a number of apex or seal portions which remain in contact with a peripheral wall of the rotor cavity of the engine throughout the rotational motion of the rotor to create a plurality of rotating cavities when the rotor rotates.

15 In Wankel engines, the inlet and exhaust ports are usually designed mechanically to allow a minimum overlap between them during the intake and exhaust portions of the cycle, such as to purge the exhaust cavity of combustion gases prior to re-filling the intake cavity with a fresh supply of air. Failure to purge the exhaust cavity of the combustion gases may result in a reduction in cycle volumetric efficiency. However, overlap of the ports may limit the range of
20 volumetric compression ratio that can be obtained. Therefore, there remains a need for improvement in optimizing how rotary engines may be operated.

SUMMARY

25 In one aspect, there is provided a rotary engine, the engine having a stator body having walls defining an internal cavity, and a rotor body mounted for eccentric revolutions within the cavity, the rotor and stator bodies cooperating to provide rotating chambers of variable volume when the rotor moves relative to the stator, the engine comprising at least an inlet port, an exhaust port and a purge port defined in the stator body and communicating with the cavity, the inlet and outlet ports being located relative to one another such that a volumetric compression ratio

of the engine is lower than a volumetric expansion ratio of the engine, the inlet port and purge port being in communication with an air source, the purge port being located rearwardly of the inlet port and forwardly of the exhaust port relative to a direction of the rotor revolution, the purge port momentarily communicating with the exhaust port through each of the chambers when the rotor is positioned in a
5 respective portion of the rotor revolution.

In another aspect, there is provided a compound engine system having a compressor, a turbine and a rotary engine with a stator body having walls defining an internal cavity and a rotor body mounted for eccentric revolutions within the
10 cavity, the rotor and stator bodies cooperating to provide rotating chambers of variable volume when the rotor moves relative to the stator, the system comprising spaced apart primary and secondary inlet ports and an exhaust port defined in the stator body and communicating with the cavity, the primary and secondary inlet ports communicating with the compressor and the exhaust port communicating with
15 the turbine, the secondary inlet port being located rearwardly of the primary inlet port and forwardly of the exhaust port relative to a direction of the revolutions, the primary inlet port and the exhaust port being positioned to define a volumetric compression ratio of the engine lower than a volumetric expansion ratio of the engine, and wherein for each of the chambers, each revolution of the rotor includes
20 an exhaust portion where the chamber contains the exhaust port, and a purge portion being part of the exhaust portion where the chamber contains both the secondary inlet port and the exhaust port.

In a further aspect, there is provided a method of operating a rotary engine, the method comprising, through each orbital revolution and rotary motion of
25 a rotor of the engine and for each chamber thereof: filling the chamber with air through an inlet port, compressing the air by reducing a volume of the chamber according to a volumetric compression ratio, mixing the compressed air with fuel and combusting a resulting air-fuel mixture, expanding combustion gases from the combustion by increasing a volume of the chamber according to a volumetric
30 expansion ratio higher than the volumetric compression ratio, expulsing the combustion gases through an exhaust port, and purging the combustion gases with air entering the chamber through a purge port distinct and spaced apart from the inlet port.

DESCRIPTION OF THE DRAWINGS

Reference is now made to the accompanying figures in which:

Fig. 1 is a schematic cross-sectional view of a rotary internal combustion engine in accordance with a particular embodiment;

5 Fig. 2 is a schematic cross-sectional view of a rotary internal combustion engine in accordance with an alternate embodiment;

Fig. 3 is a schematic cross-sectional view of a rotary internal combustion engine in accordance with another alternate embodiment;

10 Fig. 4 is a schematic cross-sectional view of a rotary internal combustion engine in accordance with yet another alternate embodiment; and

Fig. 5 is a schematic cross-sectional view of a rotary internal combustion engine in accordance with a further alternate embodiment.

DETAILED DESCRIPTION

15 Referring to Fig. 1, a rotary internal combustion engine 10 known as a Wankel engine is schematically shown. In a particular embodiment, the rotary engine 10 is used in a compound cycle engine system such as described in Lents et al.'s US patent No. 7,753,036 issued July 13, 2010 or as described in Julien et al.'s US patent No. 7,775,044 issued August 17, 2010, the entire contents of both of which are incorporated by reference herein. The compound cycle engine system
20 may be used as a prime mover engine, such as on an aircraft or other vehicle, or in any other suitable application. In any event, in such a system, air is compressed by a compressor before entering the Wankel engine, and the engine drives one or more turbine(s) of the compound engine. In another embodiment, the rotary engine 10 is used without a turbocharger.

25 The engine 10 comprises an outer body 12 having axially-spaced end walls 14 with a peripheral wall 18 extending therebetween to form a rotor cavity 20. The inner surface of the peripheral wall 18 of the cavity 20 has a profile defining two lobes, which is preferably an epitrochoid.

30 An inner body or rotor 24 is received within the cavity 20. The rotor 24 has axially spaced end faces 26 adjacent to the outer body end walls 14, and a peripheral face 28 extending therebetween. The peripheral face 28 defines three circumferentially-spaced apex portions 30, and a generally triangular profile with

outwardly arched sides. The apex portions 30 are in sealing engagement with the inner surface of peripheral wall 18 to form three rotating working chambers 32 between the inner rotor 24 and outer body 12. The geometrical axis of the rotor 24 is offset from and parallel to the axis of the outer body 12.

5 The working chambers 32 are sealed, which may typically improve efficiency. Each rotor apex portion 30 has an apex seal 52 extending from one end face 26 to the other and protruding radially from the peripheral face 28. Each apex seal 52 is biased radially outwardly against the peripheral wall 18 through a respective spring. An end seal 54 engages each end of each apex seal 52, and is
10 biased against the respective end wall 14 through a suitable spring. Each end face 26 of the rotor 24 has at least one arc-shaped face seal 60 running from each apex portion 30 to each adjacent apex portion 30, adjacent to but inwardly of the rotor periphery throughout its length. A spring urges each face seal 60 axially outwardly so that the face seal 60 projects axially away from the adjacent rotor end face 26
15 into sealing engagement with the adjacent end wall 14 of the cavity. Each face seal 60 is in sealing engagement with the end seal 54 adjacent each end thereof.

 Although not shown in the Figures, but as well understood, the rotor is journaled on an eccentric portion of a shaft and includes a phasing gear co-axial with the rotor axis, which is meshed with a fixed stator phasing gear secured to the
20 outer body co-axially with the shaft. The shaft rotates the rotor and the meshed gears guide the rotor to perform orbital revolutions within the stator cavity. The shaft performs three rotations for each orbital revolution of the rotor. Oil seals are provided around the phasing gear to prevent leakage flow of lubricating oil radially outwardly thereof between the respective rotor end face 26 and outer body end wall
25 14.

 During one orbital revolution, each chamber varies in volumes and moves around the stator cavity to undergo the four phases of intake, compression, expansion and exhaust, these phases being similar to the strokes in a reciprocating-type internal combustion engine having a four-stroke cycle.

30 The engine includes a primary inlet port 40 defined through one of the walls of the stator body 12. In the embodiment shown, the primary inlet port 40 is a side port defined in one of the end walls 14. Another opposed primary inlet port may be similarly defined in the other end wall. The primary inlet port 40 is in communication with an air source through an intake duct 34 which is defined as a

channel in the end wall 14. The air has a pressure slightly greater than the exhaust pressure of the engine. In a particular embodiment the air source is the air output of the compressor of a compound engine, though any suitable source may be used. The primary inlet port 40 delivers air to each of the chambers 32, and a fuel injection port (not shown) is also provided for delivering fuel into each chamber 32 after the air therein has been compressed. Fuel, such as kerosene (jet fuel) or other suitable fuel, is delivered into the chamber 32 such that the chamber 32 is stratified with a rich fuel-air mixture near the ignition source and a leaner mixture elsewhere, thus providing a so-called stratified charge arrangement, and the fuel-air mixture may be ignited within the housing using any suitable ignition system known in the art. In another embodiment, fuel and air can be mixed outside the engine and delivered as a pre-mixed charge through the primary inlet port 40.

The engine also includes an exhaust port 44 defined through one of the walls of the stator body 12. In the embodiment shown, the exhaust port 44 is a peripheral port defined as an opening through the peripheral wall 18. The rotary engine 10 operates under the principle of the Atkinson or Miller cycle, with its compression ratio lower than its expansion ratio. For example, the ratio obtained by dividing the volumetric compression ratio by the volumetric expansion ratio may be between 0.3 and 0.8. Accordingly, the primary inlet port 40 is located further away (i.e. measured as a function of piston rotation) from the exhaust port 44 when compared to an engine having compression and expansion ratios that are equal or approximately equal to one another. The angle of the primary inlet port 40, relative to the angle of the exhaust port 44, can then be determined to achieve a desired peak cycle pressure given the inlet air pressure. The position of the primary inlet port 40 may vary between the 7 o'clock position up to the 10 o'clock position. In the embodiment shown, the primary inlet port 40 extends between the 8 o'clock and the 9 o'clock positions.

Because of the Miller cycle implementation, the primary inlet port 40 is positioned relative to the exhaust port such that the compression ratio is significantly lower than the expansion ratio. In the embodiment shown, the primary inlet port 40 is spaced from the exhaust port 44 so that the rotor 24 at least substantially prevents communication therebetween in all rotor positions. In other words, each revolution of the rotor 24 can be said to include, for each of the chambers 32, an exhaust portion where the chamber 32 directly communicates with or contains the

exhaust port 44, and an intake portion where the chamber 32 directly communicates with or contains the inlet port 40, and the exhaust and intake portions of the revolution for a same chamber do not overlap.

5 The engine 10 also includes a secondary inlet port or purge port 42 defined through one of the walls of the stator body 12, and communicating with an air source, which may be the same source communicating with the primary inlet port 40. In the embodiment shown, the purge port 42 is a side port defined in one of the end walls 14 and communicates with the air source through the same intake duct 34 as the primary inlet port 40. The purge port 42 is located rearwardly of the primary
10 inlet port 40 and forwardly of the exhaust port 44 relative to the direction R of the rotor revolution and rotation. The purge port 42 is located such as to be in communication with the exhaust port 44 through each of the chambers 32 along a respective portion of each revolution. In other words, each revolution of the rotor 24 can be said to include, for each chamber 32, a purge portion, which is a final stage
15 of the exhaust portion, where the chamber 32 directly communicates with or contains both the purge port 42 and the exhaust port 44. In the embodiment shown, the purge port 42 is also located such as to be in communication with the primary inlet port 40 through each of the chambers 32 along a respective portion of each revolution. Alternately, the purge port 42 may be spaced from the primary inlet port
20 40 so that the rotor 24 at least substantially prevents communication therebetween in all rotor positions.

The purge port 42 may thus allow for smaller volumetric compression ratios to be achieved while still achieving adequate purging of the exhaust cavity.

25 Although not shown, the inlet ports 40, 42 may be connected to Helmholtz resonators for which may enhance volumetric efficiency and/or minimize the pumping loss during the intake phase.

In an alternate embodiment, the primary inlet port 40 is also located such as to be in communication with the exhaust port 44 through each of the chambers 32 along a respective portion of each revolution.

30 In use, through each orbital revolution of the rotor, each chamber 32 is filled with air (pressurized air from a compressor for example) through the primary inlet port 40 during the respective intake portion of the revolution, i.e. the portion of the revolution where the chamber 32 directly communicates with the primary inlet port 40. The air is then further compressed by the reducing volume of the rotating

chamber 32. Once the air is further compressed, near minimum volume of the chamber 32, the air is mixed with fuel and the resulting air-fuel mixture is ignited. The combustion gases expand and force the volume of the chamber 32 to increase. As mentioned above, the primary inlet port 40 is positioned relative to the exhaust port 44 such that the volumetric expansion ratio is higher than the volumetric compression ratio. The combustion or exhaust gases exit the chamber 32 through the exhaust port 44 during the exhaust portion of the revolution, i.e. the portion of the revolution where the chamber 32 communicates with the exhaust port 44. The last part of the exhaust portion defines the purge portion of the revolution, where the chamber 32 is in communication with both the purge port 42 and the exhaust port 44, and the air entering the chamber 32 through the purge port 42 is used to purge remaining exhaust gases from the chamber 32.

In a particular embodiment, the communication of the chamber 32 with the exhaust port 44 is closed prior to re-filling the chamber 32 with air through the inlet port 40, i.e. the inlet port 40 does not participate in the purge of the exhaust gases. In an alternate embodiment, the exhaust port 44 is still open when the inlet port 40 starts to open.

Referring to Fig. 2, an engine 110 according to another embodiment is shown, with similar elements being indicated by the same reference numerals employed in the description above. In this embodiment, the primary inlet port 140 is defined through the end wall 114 between the 9 o'clock and the 10 o'clock positions, and communicates with the air source by an intake duct 134 which is independent from the purge port 142. The secondary inlet port or purge port 142 is defined by an exit port of a purge line 136 extending through the peripheral wall 118 and having an entry port 137 opening into the cavity 20 adjacent the primary inlet port 140. As such, the air enters the adjacent chamber in communication with the primary inlet port 140, and circulates to the chamber being purged through the purge line 136 and the purge port 142. The purge port 142 is located such as to be in communication with the exhaust port 44 through each of the chambers 32 along a respective portion of each revolution, to purge the exhaust gases from the chamber 32.

The engine 110 also operates under the principle of the Atkinson or Miller cycle, with its compression ratio lower than its expansion ratio. In the embodiment shown, the rotor 24 at least substantially prevents direct communication between

the primary inlet port 140 and the exhaust port 44 in any rotor position, with communication being provided through the purge line 136. Alternately, the rotor 24 may allow the primary inlet port 140 and exhaust port 44 to be in momentary direct communication with each other through each chamber 32 sufficiently to purge burnt exhaust gases prior to ingestion of a fresh charge of air for the next combustion cycle.

Referring to Fig. 3, an engine 210 according to another embodiment is shown, again with similar elements being indicated by the same reference numerals. Like in the previous embodiment, the primary inlet port 140 is defined through the end wall 214 and communicates with the air source through an intake duct 134. The exhaust port 244 is a side port, defined in one or both of the end walls 214, and is in communication with the environment of the engine 210 through an exhaust duct 246 which is defined as a channel in the end wall 214.

The purge port 242 is a peripheral port, defined as an opening through the peripheral wall 218. The purge port 242 and exhaust port 244 communicate through each of the chambers 32 along a respective portion of each revolution to purge the exhaust gases. The purge port 242 is connected to the air source, which may be air bled from the adjacent cavity in communication with the primary inlet port 140 or the air source to which the primary inlet port 140 is connected, through a valve 248 (only schematically shown), such as to modulate the purge flow as a function of engine operation conditions, allowing selective recirculation of some of the exhaust gases, for example to optimize the power output, minimize the emission levels, or for another purpose, as will be further detailed below. Although not shown, a similar valve may connect the primary inlet port 140 to the air source.

The engine 210 also operates under the principle of the Atkinson or Miller cycle, with its compression ratio lower than its expansion ratio. In the embodiment shown, the rotor 24 prevents direct communication between the primary inlet port 140 and the exhaust port 244 in any rotor position. Alternately, the rotor 24 may allow the primary inlet port 140 and exhaust port 244 to be in momentary direct communication with each other through each chamber 32.

Referring to Fig. 4, an engine 310 according to yet another embodiment is shown. The engine 310 is similar to the engine 210, with a similar purge port 242 and corresponding valve 248 (and optional valve, not shown, on the inlet port 140), but the position of the exhaust port 344 differs. In this embodiment, the rotor 24

prevents direct communication between the secondary inlet port or purge port 242 and the exhaust port 344 in all rotor positions. A secondary exhaust port 347 is provided in the form of a peripheral port defined as an opening through the peripheral wall 318. The secondary exhaust port 347 is located forwardly of the primary exhaust port 344 and rearwardly of the purge port 242 along the direction of revolution R, in proximity to the primary exhaust port 344. The purge port 242 and secondary exhaust port 347 communicate through each of the chambers 32 along a respective portion of each revolution to purge the exhaust gases, after communication of the chamber 32 with the primary exhaust port 344 has been blocked, to purge the chamber 32.

The engine 310 also operates under the principle of the Atkinson or Miller cycle, with its compression ratio lower than its expansion ratio. In the embodiment shown, the rotor 24 prevents direct communication between the primary inlet port 140 and the exhaust ports 347, 344 in all rotor positions.

Referring to Fig. 5, an engine 410 according to a further embodiment is shown. The engine 410 has a primary inlet port 440 located between the 8 o'clock and 9 o'clock positions, and a secondary inlet port or purge port 442, with both inlet ports 440, 442 being defined in the form of peripheral ports as openings through the peripheral wall 418. The primary inlet port 440 and secondary inlet port 442 are each connected to a same connecting duct 456, which can be for example a plenum, a Y-piece, etc., through a respective conduit 434, 436. Each conduit includes a valve 448, 450 therein that can selectively open or close it. The connecting duct 456 communicates with the air source, for example the exhaust of a compressor in the case of a compound cycle engine system, through an intake duct 458. The exhaust port 44 is a peripheral port similar to that of the embodiments of Figs. 1-2.

In the embodiment shown, the rotor 24 prevents direct communication between the primary inlet port 440 and the exhaust port 44 in any rotor position. Alternately, the rotor 24 may allow the primary inlet port 440 and exhaust port 44 to be in momentary direct communication with each other through each chamber 32.

The valves 448, 450 which can be for example pneumatic, electric or hydraulic valves, are controlled, either passively or electronically, to modulate the flow between the primary and secondary inlet ports 440, 442, to vary the pressure ratios of the engine to optimize the engine operation at off-design conditions. Such

modulation may allow for a suitable trade-off between mission fuel burn, engine power and exhaust gas atmospheric emissions or other factors.

In a particular embodiment, the valves 448, 450 are controlled as follows during three different stages of operation of the engine.

5 In use, in one example such as during a first operational stage, which corresponds to engine start-up, the primary valve 450 is closed or substantially closed, and the secondary valve 448 is open, so that only (or primarily) the secondary inlet port 442 delivers air to the chambers 32. Doing so may allow for a relatively higher volumetric compression ratio than would otherwise be available,
10 which increases the air temperature and facilitates combustion, which it turn may facilitate start-up, and perhaps especially during cold starts. The secondary inlet port 442 may be positioned such that the engine in this configuration has a volumetric compression ratio which is near, e.g. equal or substantially equal, to the volumetric expansion ratio of the engine.

15 In another example, during a second operational stage of the engine, which corresponds to engine idle or low power operation, the secondary valve 448 is closed or substantially closed, either abruptly or progressively, and the primary valve 450 is open. With the secondary valve 448 closed, purging of the exhaust gases is significantly reduced/impeded (if the primary inlet port 440 and exhaust port 44
20 communicate) or prevented (if the rotor 24 prevents communication between the primary inlet port 440 and exhaust port 44), which reduces exhaust and thus may help minimize the emission levels of the engine when in this condition. The primary inlet port 440 is positioned such that the engine in this configuration operates under the principle of the Atkinson or Miller cycle, with its compression ratio lower than its
25 expansion ratio.

 In another example, during a third operational stage of the engine, which corresponds to high power operation of the engine, both valves 448, 450 are open, so that the secondary inlet port 442 acts as a purge port as discussed above. The secondary valve 448 may be opened, partially or completely, as the power demand
30 increases. The relatively lower volumetric compression ratio of the Atkinson or Miller cycle (as compared to standard cycles) combined with the purging of the exhaust gases from the cavities help maximize power output. In a particular embodiment, the third operational stage may start at approximately 50-80% of maximum power of the engine. However this point can be varied by an electronic control (not shown)

sending a signal to the valve actuator to vary the opening of the valve such that the desired outputs (power, emissions, fuel consumption and exhaust gas temperature) are optimized for different operating conditions such as ambient temperature, altitude, throttle levels and rotor speeds.

5 Similar valves and controls may be provided with other embodiments, for example the embodiments shown in Figs. 3-4. Air to the inlet ports may be controlled in other engine operational stages, or scenarios, to provide specific benefits or operational effects, as desired.

10 The above description is meant to be exemplary only, and one skilled in the art will recognize that changes may be made to the embodiments described without departing from the scope of the invention(s) disclosed. For example, elements of different embodiments such as locations, configurations and shapes of the various ports may be combined differently than shown. The examples apply to both peripheral and side inlet/exhaust ports, or any suitable combination thereof.

15 Any suitable fuel & ignition systems may be employed. The term "valve" is intended to encompass any suitable airflow regulation apparatus which may be used to achieve the airflow control effects described; any suitable valving arrangement may be employed. Any suitable number of inlet ports may be employed. The present teachings may be applied to any suitable rotary engine, such as a rotary vane

20 pumping machine or other suitable engine, and is thus not limited in application to Wankel engines. Other modifications which fall within the scope of the present invention will be apparent to those skilled in the art, in light of a review of this disclosure, and such modifications are intended to fall within the appended claims.

25

CLAIMS:

1. A rotary engine, the engine comprising a stator body having walls defining an internal cavity, and a rotor body mounted for eccentric revolutions within the cavity, the rotor and stator bodies cooperating to provide rotating chambers of variable volume when the rotor moves relative to the stator, the engine comprising at least an inlet port, an exhaust port and a purge port defined in the stator body and communicating with the cavity, the inlet and outlet ports being located relative to one another such that a volumetric compression ratio of the engine is lower than a volumetric expansion ratio of the engine and such that the rotor body prevents communication between the inlet and exhaust ports through the rotating chambers in any rotor position, the inlet port and purge port being in communication with an air source, the purge port being located rearwardly of the inlet port and forwardly of the exhaust port relative to a direction of the rotor revolution, the purge port momentarily communicating with the exhaust port through each of the chambers when the rotor is positioned in a respective portion of the rotor revolution.

2. The engine as defined in claim 1, wherein the engine is a Wankel engine, with the stator body defining an internal cavity having an epitrochoid shape with two lobes, and the rotor body having three circumferentially spaced apex portions, the rotor body being engaged to an eccentric portion of a shaft, the rotor performing orbital revolutions within the cavity with each of the apex portions remaining in sealing engagement with a peripheral one of the stator walls and separating three rotating chambers, the inlet port and the purge port being defined in a same one of the two lobes.

3. The engine as defined in claim 1, wherein the inlet port and purge port are in communication with a same air source through a same intake duct.

4. The engine as defined in claim 1, wherein the purge port is defined by a purge line through the stator body and forming a communication with an adjacent one of the chambers, the adjacent one of the chambers being in communication with the inlet port.

5. The engine as defined in claim 1, wherein the exhaust port is a primary exhaust port, the stator body having a secondary exhaust port defined therein in proximity of the primary exhaust port with the secondary exhaust port being located forwardly of the primary exhaust port and rearwardly of the purge port along the direction of the revolutions, the rotor also preventing communication between the purge port and the primary exhaust port in all rotor positions.

6. The engine as defined in claim 1, wherein the purge port communicates with the air source through a valve.

7. A compound engine system comprising a compressor, a turbine and a rotary engine, the rotary engine having a stator body having walls defining an internal cavity and a rotor body mounted for eccentric revolutions within the cavity, the rotor and stator bodies cooperating to provide rotating chambers of variable volume when the rotor moves relative to the stator, the system comprising spaced apart primary and secondary inlet ports and an exhaust port defined in the stator body and communicating with the cavity, the primary and secondary inlet ports communicating with the compressor and the exhaust port communicating with the turbine, the secondary inlet port being located rearwardly of the primary inlet port and forwardly of the exhaust port relative to a direction of the revolutions, the primary inlet port and the exhaust port being positioned to define a volumetric compression ratio of the engine lower than a volumetric expansion ratio of the engine, and wherein for each of the chambers, each revolution of the rotor includes an exhaust portion where the chamber contains the exhaust port, a purge portion being part of the exhaust portion where the chamber contains both the secondary inlet port and the exhaust port, and a primary intake portion where the chamber contains the primary inlet port, the exhaust portion and the primary intake portion being non-overlapping such that the rotor body prevents communication between the primary inlet and exhaust ports through the rotating chambers in any rotor position.

8. The engine as defined in claim 7, wherein the rotary engine is a Wankel engine, with the stator body defining an internal cavity having an epitrochoid shape with two lobes, and the rotor body having three circumferentially spaced apex portions, the rotor body being engaged to an eccentric portion of a shaft, the rotor performing orbital revolutions within the cavity with each of the apex portions remaining in sealing engagement with a peripheral one of the stator walls and separating three rotating chambers, the primary and secondary inlet ports being defined in a same one of the two lobes.

9. The engine as defined in claim 7, wherein the primary and secondary inlet ports are in communication with the compressor through a same intake duct.

10. The engine as defined in claim 7, wherein the secondary inlet port is defined by a purge line through the stator body forming a communication with an adjacent one of the chambers, the adjacent one of the chambers being in communication with the primary inlet port.

11. The engine as defined in claim 7, wherein the exhaust port is a primary exhaust port, the stator body having a secondary exhaust port defined therein in proximity of the primary exhaust port with the secondary exhaust port being located forwardly of the primary exhaust port and rearwardly of the secondary inlet port along the direction of the revolutions, and for each of the chamber, each revolution of the rotor including a primary exhaust portion where the chamber contains the primary exhaust port, the primary exhaust portion and the purge portions being non-overlapping.

12. The engine as defined in claim 7, wherein the secondary inlet port communicates with the compressor through a valve.

13. A method of operating a rotary engine, the method comprising, through each orbital revolution and rotary motion of a rotor of the engine and for each chamber thereof: filling the chamber with air through an inlet port; compressing the air by reducing a volume of the chamber according to a volumetric compression ratio; mixing the compressed air with fuel and combusting a resulting air-fuel mixture; expanding combustion gases from the combustion by increasing a volume of the chamber according to a volumetric expansion ratio higher than the volumetric compression ratio; expelling the combustion gases through a primary exhaust port; closing a communication of the chamber with the primary exhaust port; and purging the combustion gases through a secondary exhaust port distinct from the primary exhaust port with air entering the chamber through a purge port distinct and spaced apart from the inlet port.

14. The method as defined in claim 13, further comprising, after purging the combustion gases, closing a communication of the chamber with the secondary exhaust port prior to filling the chamber with air through the inlet port.

15. The method as defined in claim 13, wherein purging the combustion gases includes circulating the air from an air source through a duct also communicating with the inlet port.

16. The method as defined in claim 13, wherein purging the combustion gases includes circulating the air through a conduit communicating with an adjacent chamber of the engine receiving the air from the inlet port.

17. The method as defined in claim 13, wherein purging the combustion gases includes opening a valve regulating a communication between the purge port and an air source.

18. A rotary engine comprising: a stator body having walls defining an internal cavity; a rotor body mounted for eccentric revolutions within the internal cavity, the rotor and stator bodies cooperating to provide chambers of variable volume when the rotor body moves relative to the stator body; at least an inlet port, an exhaust port and a purge port defined in the stator body and communicating with the cavity, the inlet port and purge port being in communication with an air source, the purge port being located rearwardly of the inlet port and forwardly of the exhaust port relative to a direction of the eccentric revolutions of the rotor body; wherein the purge port momentarily communicates with the exhaust port through each of the chambers when the rotor body is positioned in a respective portion of each of the revolutions of the rotor body; and wherein the inlet and exhaust ports are located relative to one another such that the rotor body prevents communication between the inlet and exhaust ports throughout the eccentric revolutions of the rotor body.

19. The engine as defined in claim 18, wherein the engine is a Wankel engine, with the stator body defining the internal cavity having an epitrochoid shape with two lobes, and the rotor body having three circumferentially spaced apex portions, the rotor body being engaged to an eccentric portion of a shaft, each of the apex portions remaining in sealing engagement with a peripheral one of the stator walls and separating the chambers.

20. The engine as defined in claim 18, wherein the inlet port and purge port are in communication with the air source through a common intake duct.

21. The engine as defined in claim 18, wherein the purge port is defined by a purge line forming a communication with an adjacent one of the chambers, the adjacent one of the chambers being in communication with the inlet port.

22. The engine as defined in claim 18, wherein the exhaust port is a primary exhaust port, the stator body having a secondary exhaust port defined therein in proximity of the primary exhaust port with the secondary exhaust port being located forwardly of the primary exhaust port and rearwardly of the purge port along the direction of the eccentric revolutions, the rotor also preventing communication between the purge port and the primary exhaust port in all rotor positions.

23. The engine as defined in claim 18, wherein the purge port communicates with the air source through a valve.

24. A compound engine system comprising: a compressor; a turbine; and a rotary engine, the rotary engine including: a stator body having walls defining an internal cavity, a rotor body mounted for eccentric revolutions within the cavity, the rotor and stator bodies cooperating to provide chambers of variable volume when the rotor moves relative to the stator, spaced apart primary and secondary inlet ports and an exhaust port defined in the stator body and communicating with the internal cavity, the primary and secondary inlet ports communicating with the compressor and the exhaust port communicating with the turbine, the secondary inlet port being located rearwardly of the primary inlet port and forwardly of the exhaust port relative to a direction of the eccentric revolutions; wherein for each of the chambers, each of the eccentric revolutions of the rotor includes an exhaust portion where the chamber contains the exhaust port, a purge portion being part of the exhaust portion where the chamber contains both the secondary inlet port and the exhaust port, and a primary intake portion where the chamber contains the primary inlet port, the exhaust portion and the primary intake portion being non-overlapping such that the rotor body prevents communication between the inlet and exhaust ports through the chambers in any rotor position.

25. The engine as defined in claim 24, wherein the rotary engine is a Wankel engine, with the stator body defining an internal cavity having an epitrochoid shape with two lobes, and the rotor body having three circumferentially spaced apex portions, the rotor body being engaged to an eccentric portion of a shaft, the rotor performing orbital revolutions within the cavity with each of the apex portions remaining in sealing engagement with a peripheral one of the stator walls and separating three rotating chambers.

26. The engine as defined in claim 24, wherein the primary and secondary inlet ports are in communication with the compressor through a common intake duct.

27. The engine as defined in claim 24, wherein the secondary inlet port is defined by a purge line forming a communication with an adjacent one of the chambers, the adjacent one of the chambers being in communication with the primary inlet port.

28. The engine as defined in claim 24, wherein the exhaust port is a primary exhaust port, the stator body having a secondary exhaust port defined therein in proximity of the primary exhaust port with the secondary exhaust port being located forwardly of the primary exhaust port and rearwardly of the secondary inlet port along the direction of the eccentric revolutions, and for each of the chambers, each of the eccentric revolutions of the rotor includes a primary exhaust

portion where the chamber contains the primary exhaust port, the primary exhaust portion and the purge portions being non-overlapping.

29. The engine as defined in claim 24, wherein the secondary inlet port communicates with the compressor through a valve.

30. A method of operating a rotary engine, the method comprising, through each orbital revolution and rotary motion of a rotor of the engine and for each chamber thereof: filling the chamber with air through an inlet port; compressing the air by reducing a volume of the chamber; mixing the compressed air with fuel and combusting a resulting air-fuel mixture; expanding combustion gases from the combustion by increasing a volume of the chamber; expelling the combustion gases through a primary exhaust port; closing a communication of the chamber with the primary exhaust port; and purging the combustion gases through a secondary exhaust port distinct from the primary exhaust port with air entering the chamber through a purge port distinct and spaced apart from the inlet port.

31. The method as defined in claim 30, further comprising, after the purging of the combustion gases, closing a communication of the chamber with the secondary exhaust port prior to filling the chamber with air through the inlet port.

32. The method as defined in claim 30, wherein the purging of the combustion gases includes circulating the air from an air source through a duct also communicating with the inlet port.

33. The method as defined in claim 30, wherein the purging of the combustion gases includes circulating the air through a conduit communicating with an adjacent chamber of the engine receiving the air from the inlet port.

34. The method as defined in claim 30, wherein the purging of the combustion gases includes opening a valve regulating a communication between the purge port and an air source.

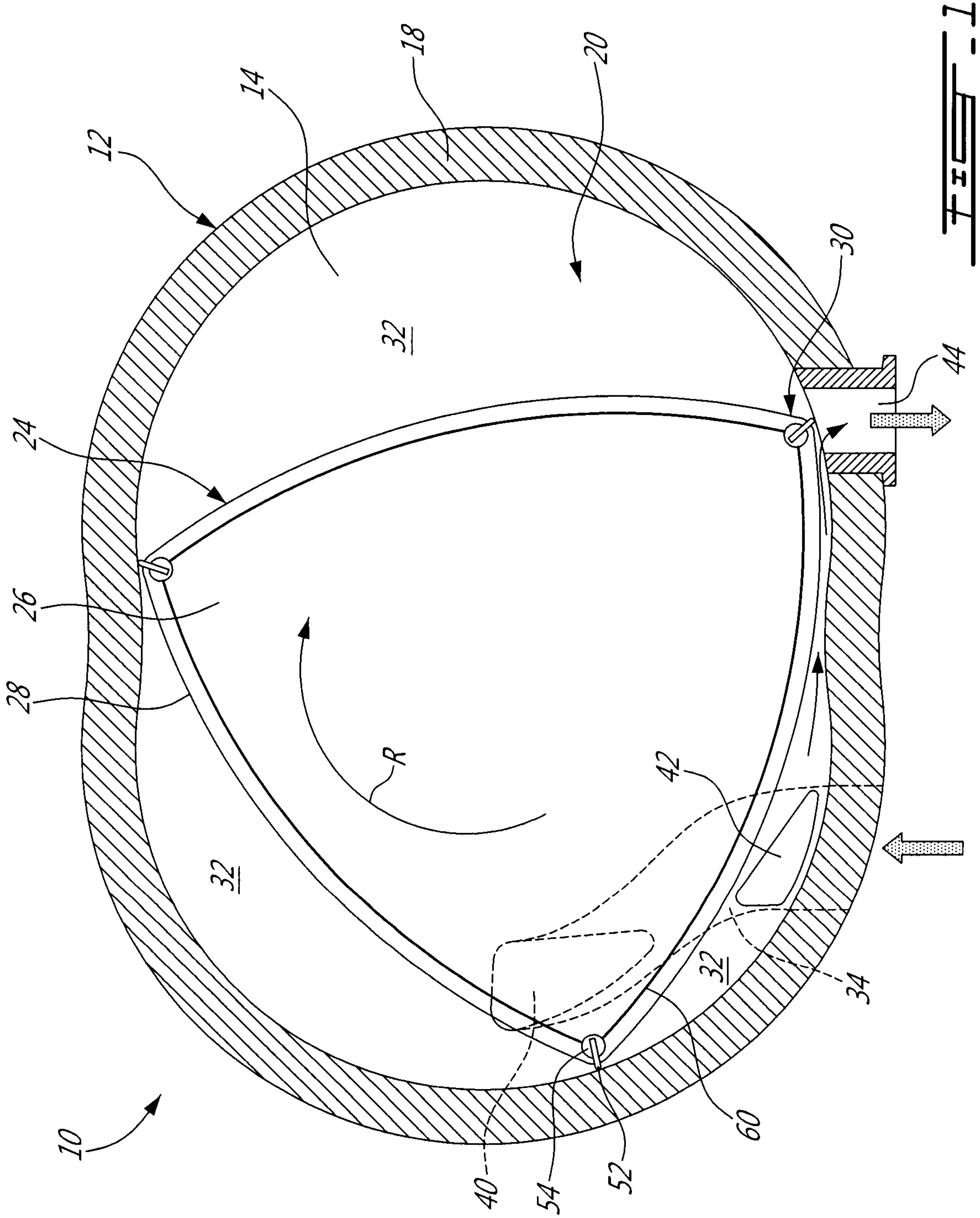


FIG. 1

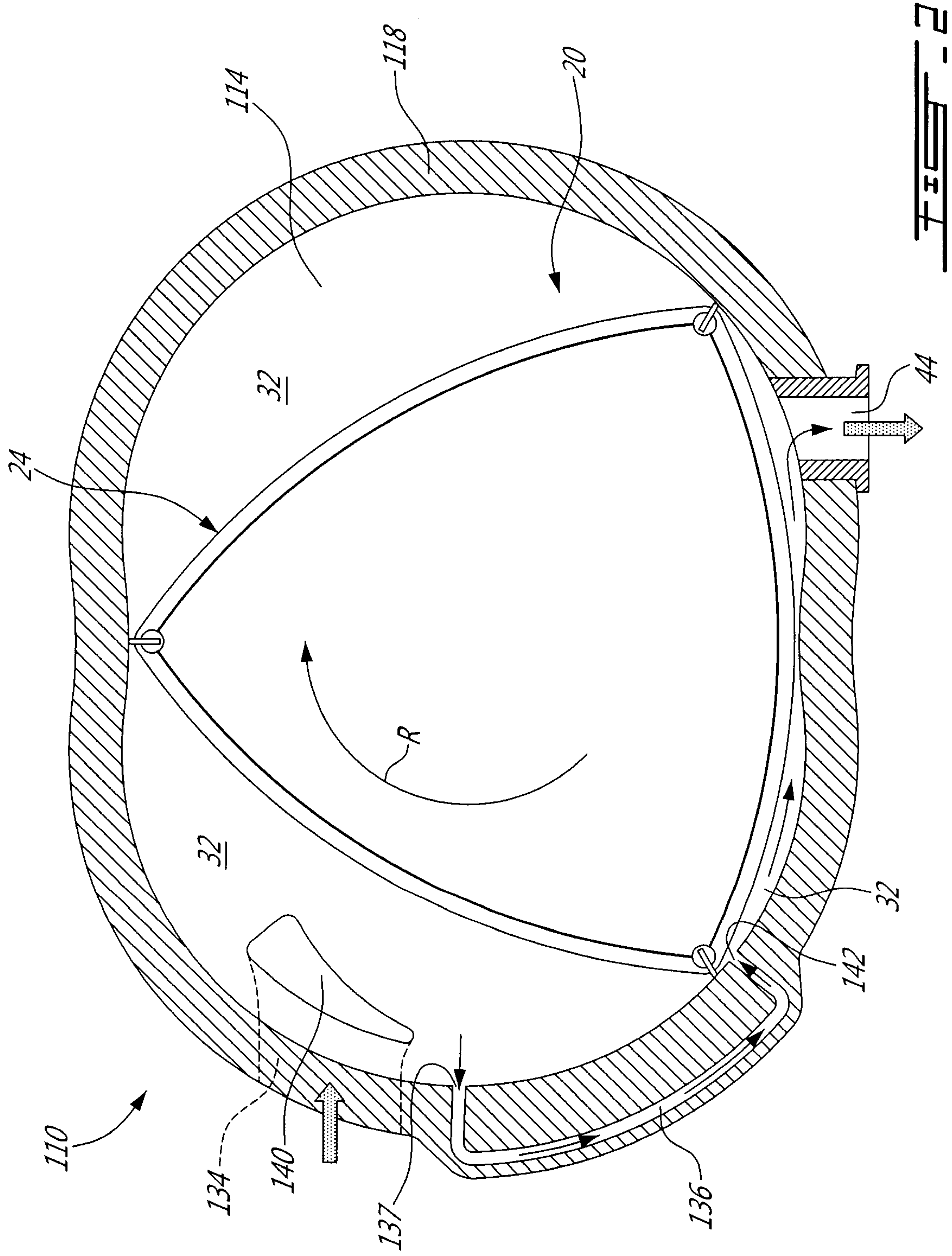


FIG. 2

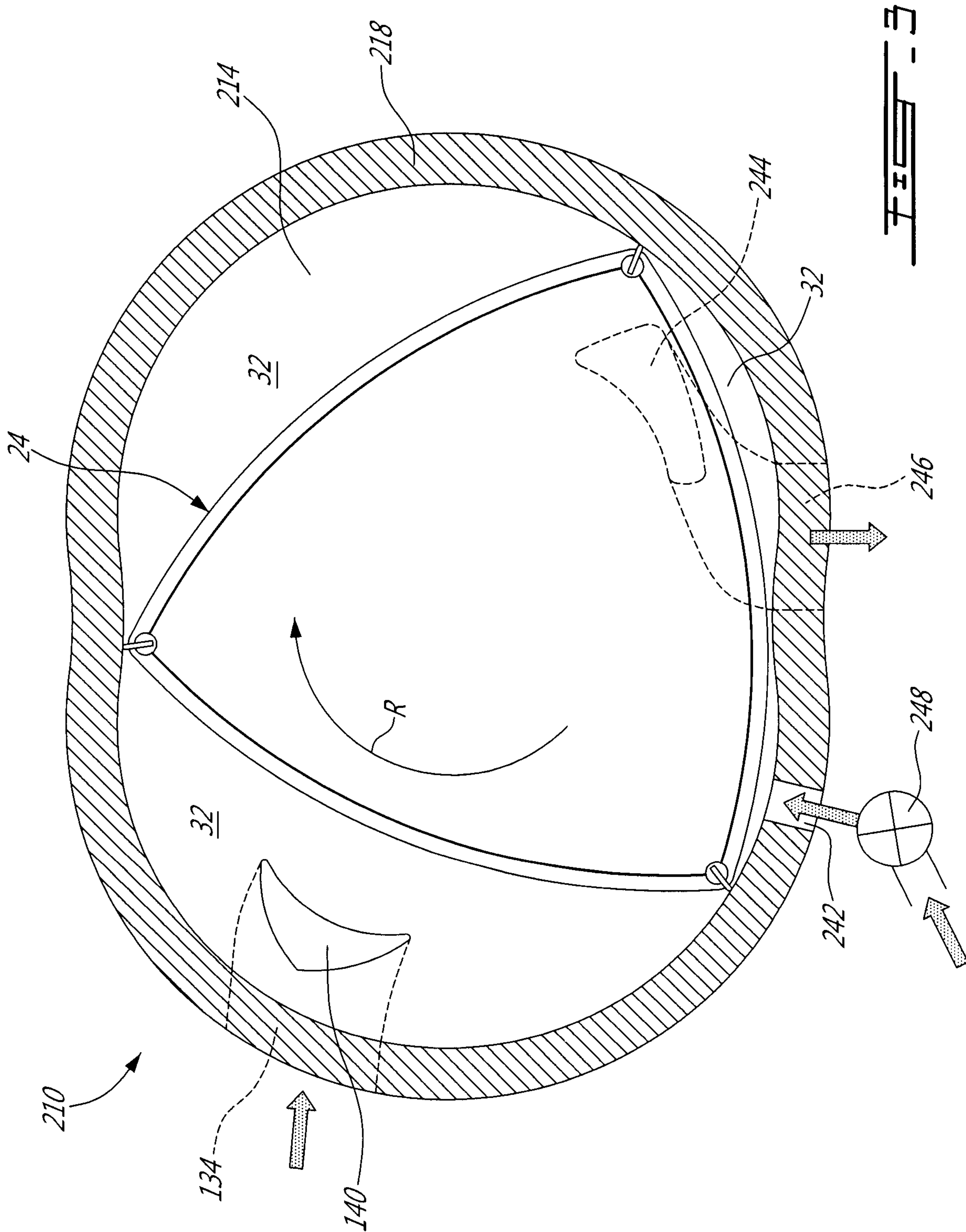


FIG. 3

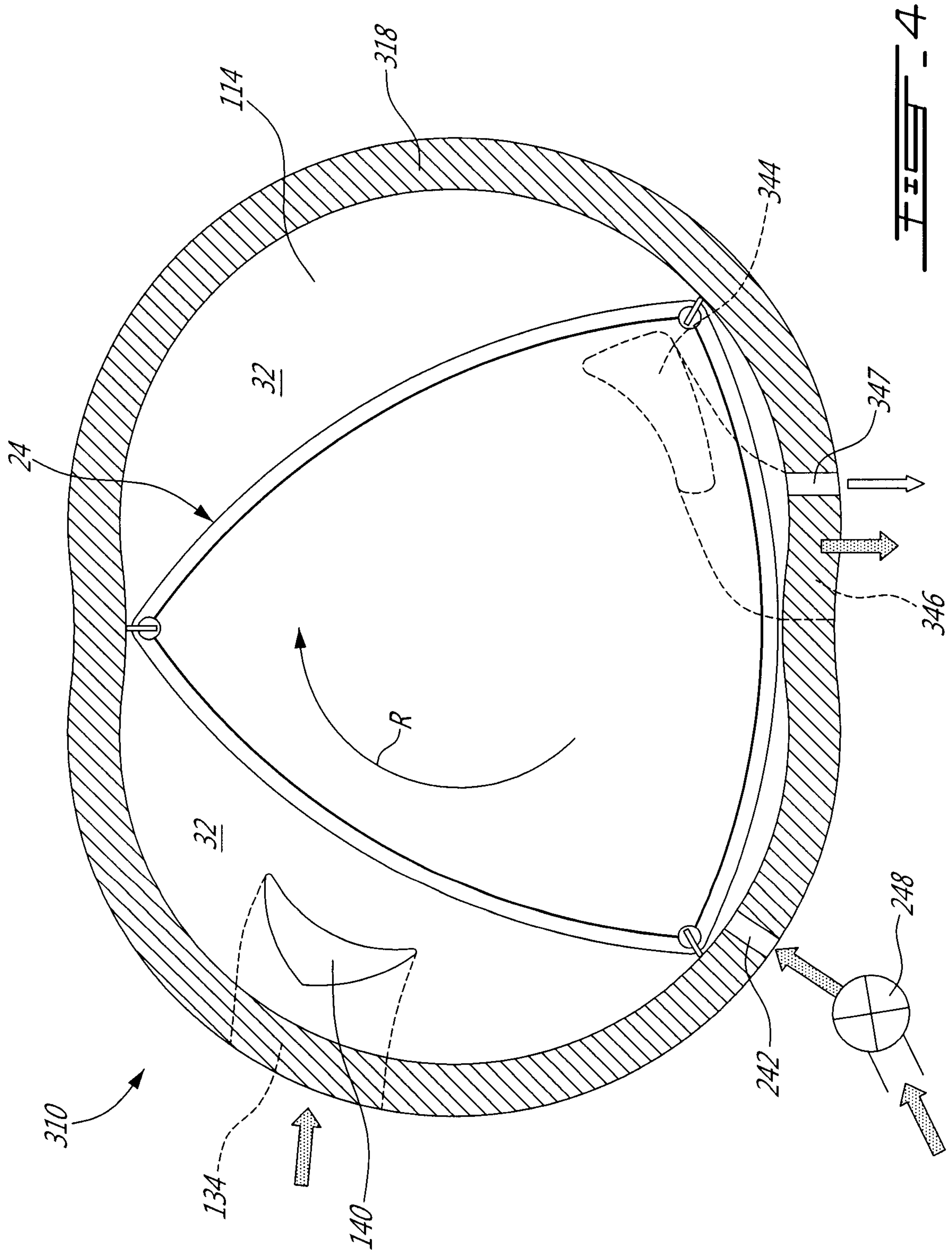


FIG. 4

