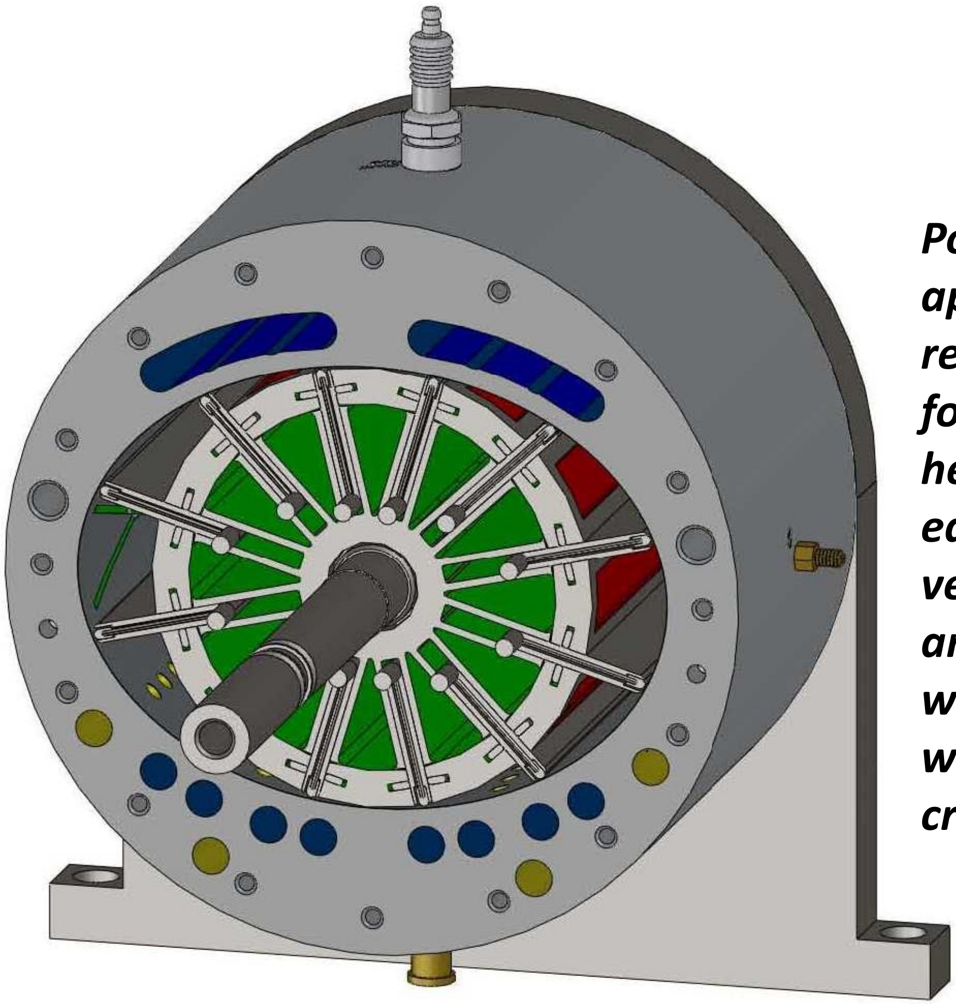
Circle Ellipse Engine

Evolutionary, Lightweight, Symmetrical, Scalable, 5 Major Parts

The Circle Ellipse Engine is shown with end plate removed. Pseudo color is used to highlight functions: cooling water (blue), air intake and exhaust (yellow), lubrication (green), and combustion (red)



Potential market applications include replacement engines for trucks, buses, & heavy construction equipment, aerial vehicles, automobiles, and any application where reduced size, weight, and cost are critical.

Circle Ellipse Engine

Evolutionary, Lightweight, Symmetrical, Scalable, 5 Major Parts

The Circle Ellipse Engine is Compact, Lightweight, and easily scaled from a small lawn mower size to an extreme large container ship size. Its design leverages Lessons Learned from the Wankel Engine Development, and addresses all issues of lubrication, cooling, sealing, thermodynamics, and mechanical interfaces.

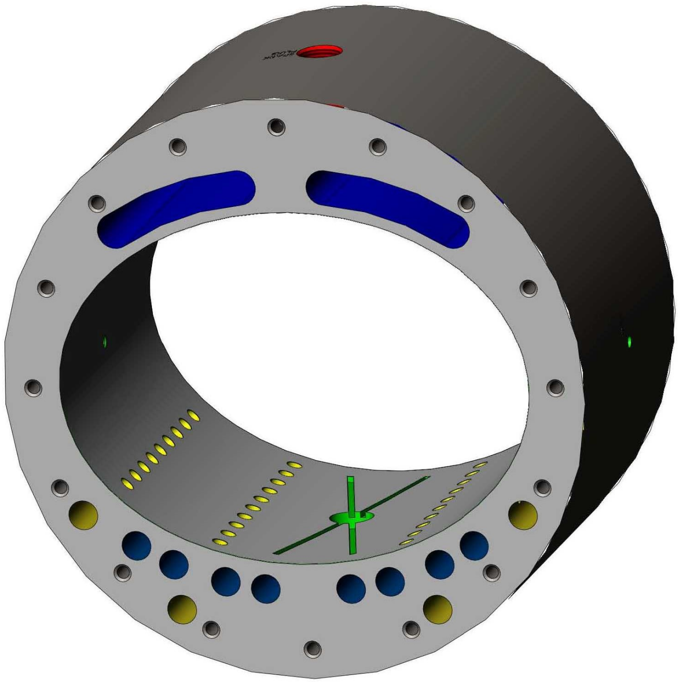
There are only five major unique parts. These are the Housing, Rotor, Vanes, End Plates, and Drive Shaft. The engine's small size and weight are possible by elimination of pistons, intake and exhaust valves, rocker arms, lifters, cam shaft, crank shaft, journal bearings, timing chains, and related components.

All engine accessories are the same — alternator, pumps for water, oil, power steering, air conditioning, etc. Intake air and exhaust are managed by identical components — filters, mufflers, etc.

Circle Ellipse Engine

Evolutionary, Lightweight, Symmetrical, Scalable, 5 Major Parts

The Circle Ellipse Engine HOUSING includes water, oil, air, and exhaust passageways. There are no moving parts. Pseudo color is used to explain the passageways, as follows: Cooling water (blue), Air Intake and Exhaust (yellow), Lubrication (green), and Combustion (red).



The Housing is Aluminum. A water jacket along the perimeter provides for thermal stability (blue).

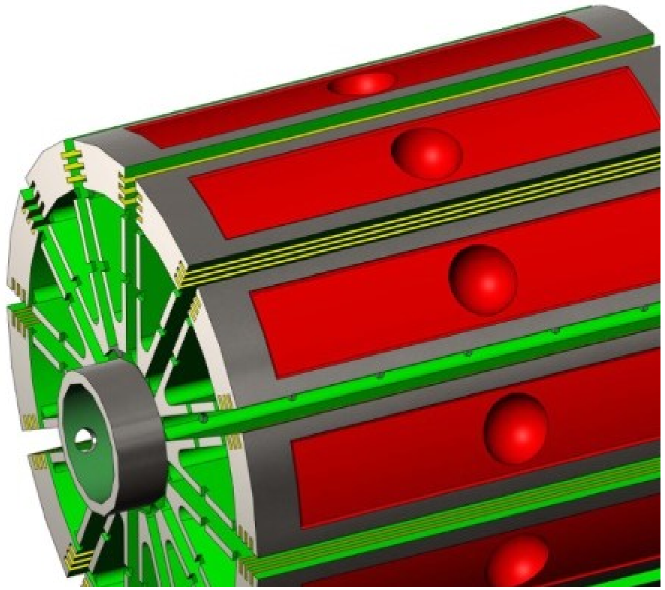
Oil Flow Restrictors lubricate the apex seals. A plenum aids in distribution. Oil is evacuated each rotation into a sump where air/foam settles, is filtered, and returned to the engine (green).

Air and Exhaust enter/exit through distribution ports into combustion sectors (yellow).

Circle Ellipse Engine

Evolutionary, Lightweight, Symmetrical, Scalable, 5 Major Parts

The ROTOR is round and 100% symmetrical. Each sector has a combustion pocket (red) optimized for fuel resonance time. The central hub receives cooling oil from the driveshaft (green), and distributes the oil into slots for vanes and vane seals. An abundance of openings assure even oil distribution.



The rotor is partitioned into 12 sectors. Each sector includes slots for vanes, and multiple vane seals to isolate combustion areas from lubrication areas. In combination with the drive shaft, the rotor mass provides the fly wheel function.

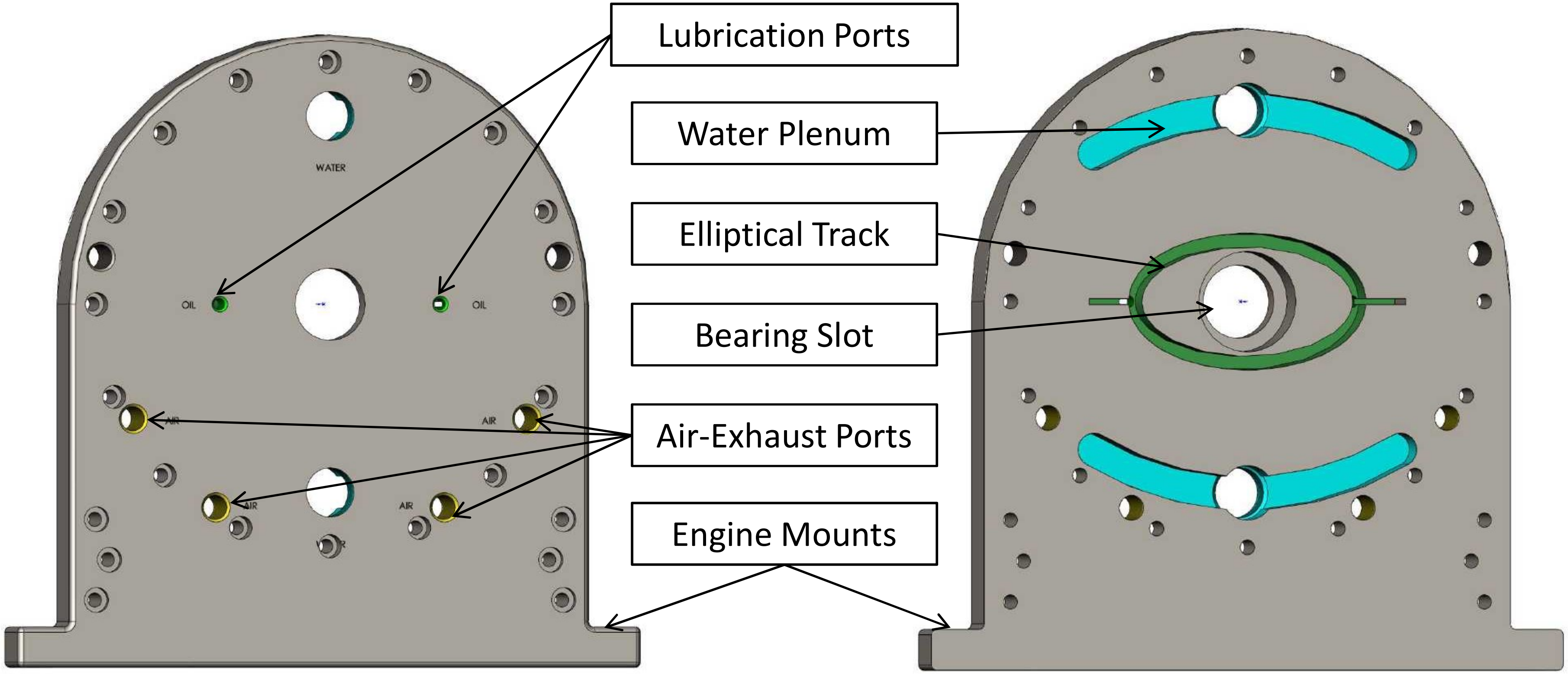
Lubrication and Cooling oil enters the rotor through the driveshaft, and lubricates the seals. The balance of oil is used for rotor thermal stability.

Engine displacement size is determined by Rotor diameter and length, in conjunction with the elliptical opening in the Housing.

Circle Ellipse Engine

Evolutionary, Lightweight, Symmetrical, Scalable, 5 Major Parts

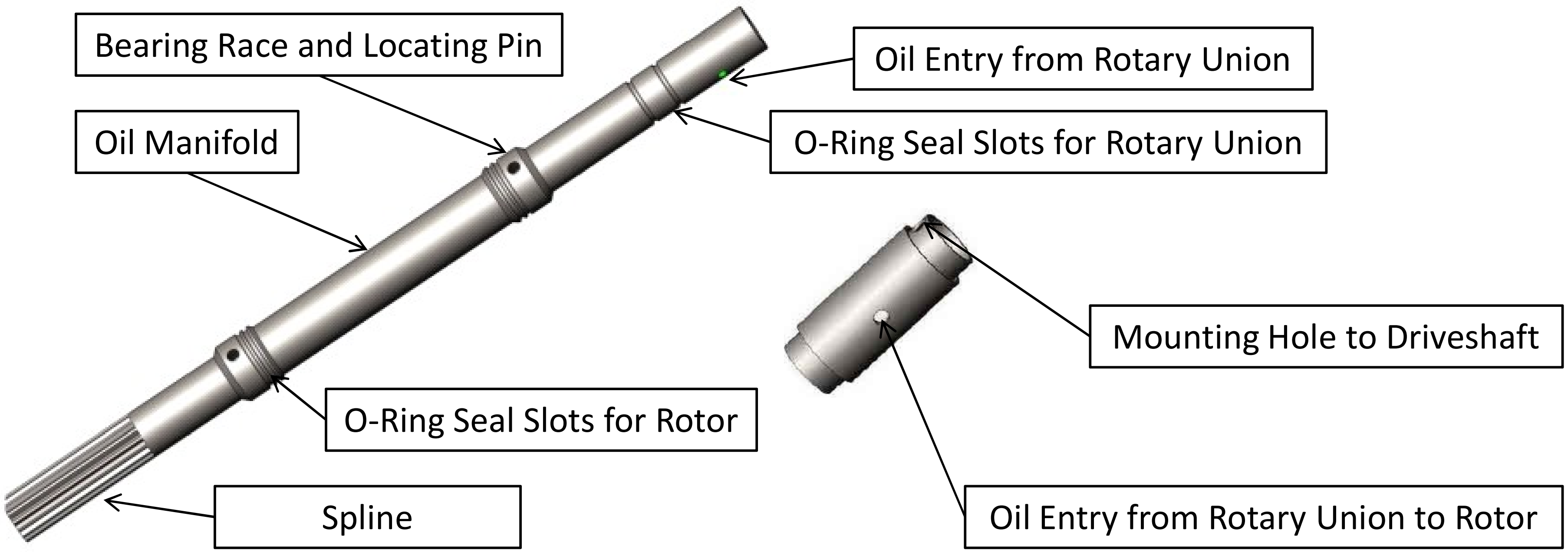
The END PLATE provides the connections for water, oil, air, and exhaust. Each end plate has a commercial bearing slot, a water plenum and distribution passageway (blue), and an Elliptical Track to control the radial position of the vanes (green), Identical fasteners facilitate connection to sides of the housing.



Circle Ellipse Engine

Evolutionary, Lightweight, Symmetrical, Scalable, 5 Major Parts

The DRIVE SHAFT is inserted through the center of the rotor. A commercial Rotary Union is attached to one end to couple cooling and lubricating oil through an internal passageway to a plenum inside the rotor. Other features include a spline on one end to deliver rotary power. There are stepped sections for correct placement of the inner race of the commercial bearings.

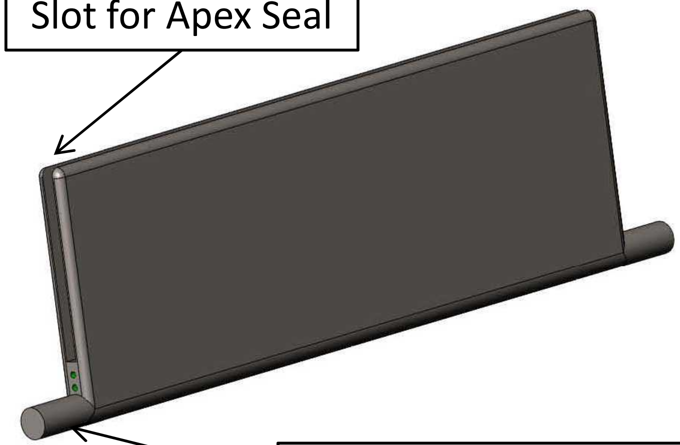


Circle Ellipse Engine

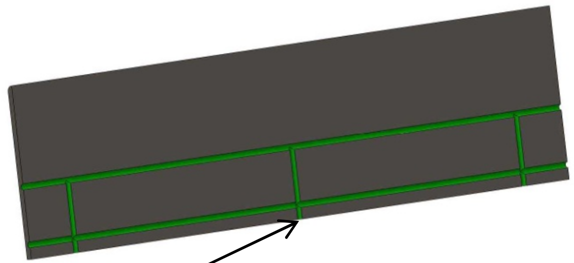
Evolutionary, Lightweight, Symmetrical, Scalable, 5 Major Parts

There are 12 VANES inserted into rotor vane slots. Each pair of adjacent Vanes provides the opposite walls of a combustion chamber. The tip of the vane has a slot for an apex seal, derived from the identical counterpart in the Wankel Engine. The pins on the vane ends fit into a vane track in the end plates. As the rotor turns, the Vanes are propelled, so that the Vane tip is maintained a precise distance from the housing ellipse cavity. The Apex Seals make the final complete seal with the inner surface of the Housing. Internal passageways provide for lubrication of the vanes and the Apex Seals.

Slot for Apex Seal



Position Pin for Vane Track in End Plate

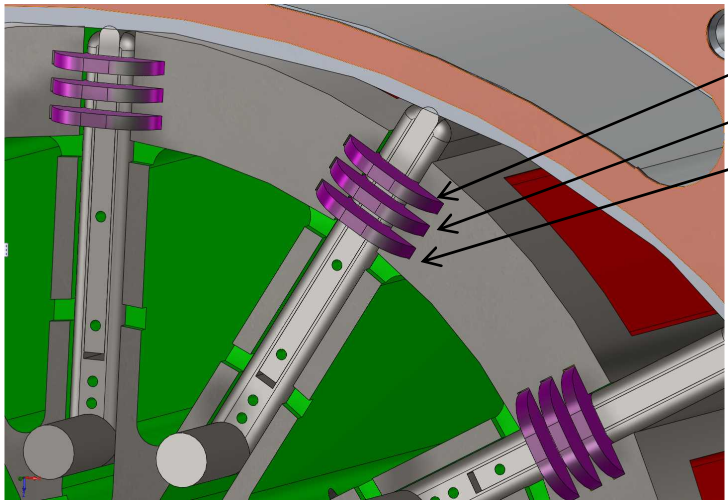


Apex Seal (cutaway) showing oil passageways

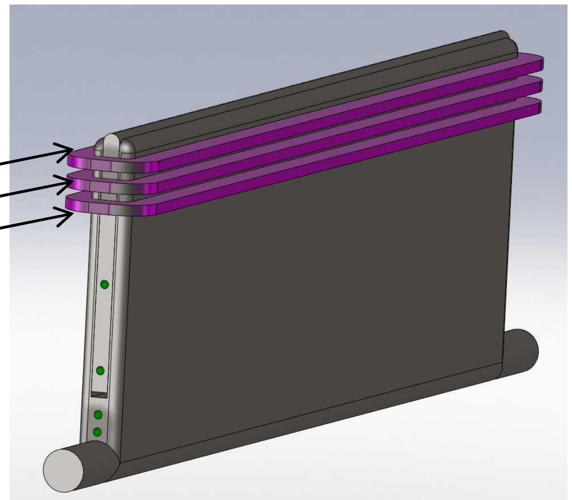
Circle Ellipse Engine

Evolutionary, Lightweight, Symmetrical, Scalable, 5 Major Parts

- In the Circle Ellipse Engine, low mass vanes reciprocate instead of larger pistons.
- The vanes are accurately positioned by pins that are inserted in pin tracks.
- An apex seal completes the length gliding across the inner elliptical surface of the housing.
- The Vane Seal function is similar to that of a piston ring, except:
  - it is stationary (in the rotor) and not reciprocating like a piston in cylinder
  - It has a racetrack profile matching the vane, not round like a piston
  - It expands contract against the vane profile instead of expanding against the cylinder wall.



Vanes are shown installed in Rotor. Three Vane Seals surround Vanes and block combustion gases from contaminating lubrication oil, and lubrication oil from entering the combustion chamber preventing NOx pollutants.



Circle Ellipse Engine

Evolutionary, Lightweight, Symmetrical, Scalable, 5 Major Parts

The Circle Ellipse Engine is shown with a transparent End Plate. Unlike the Wankel engine, which implements complex geometry called an Epitrochoid to implement the Otto Cycle, the Circle Ellipse Engine satisfies all requirements of the Otto Cycle with simple, symmetrical geometry.

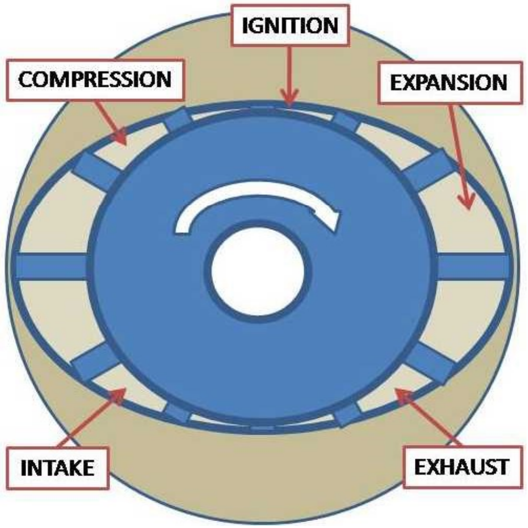
As the rotor turns, the Circle Ellipse Engine executes the Otto Cycle: Intake, Compression, Combustion, and Exhaust. The engine is normally aspirated. Intake air is drawn into an expanding sector, then compressed. In the gasoline version, the spark plug serves the same well-known purpose, and the combusted gas-air mixture rapidly expands. The final sector expels the exhaust gases. The Circle Ellipse Engine completes the Otto Cycle every rotation, unlike the two piston cycles of a reciprocating engine, so it achieves the same power as a reciprocating engine at HALF the RPM.

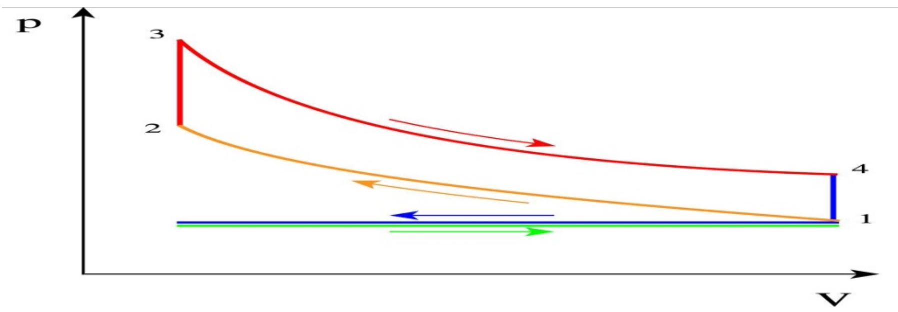
Circle Ellipse Engine

Evolutionary, Lightweight, Symmetrical, Scalable, 5 Major Parts

An OTTO CYCLE is an idealized thermodynamic cycle that describes the functioning of a typical spark ignition piston engine. It is the thermodynamic cycle most commonly found in truck and automobile engines.

Shown below is an idealized diagram of a four-stroke Otto cycle. The intake stroke (1) is performed by an isobaric expansion, followed by an adiabatic compression stroke (2). Through the combustion of fuel, heat is added in a constant volume (isochoric process) process, followed by an adiabatic expansion process power stroke (3). The cycle is completed by the exhaust stroke (4), characterized by isochoric cooling and isentropic compression processes.



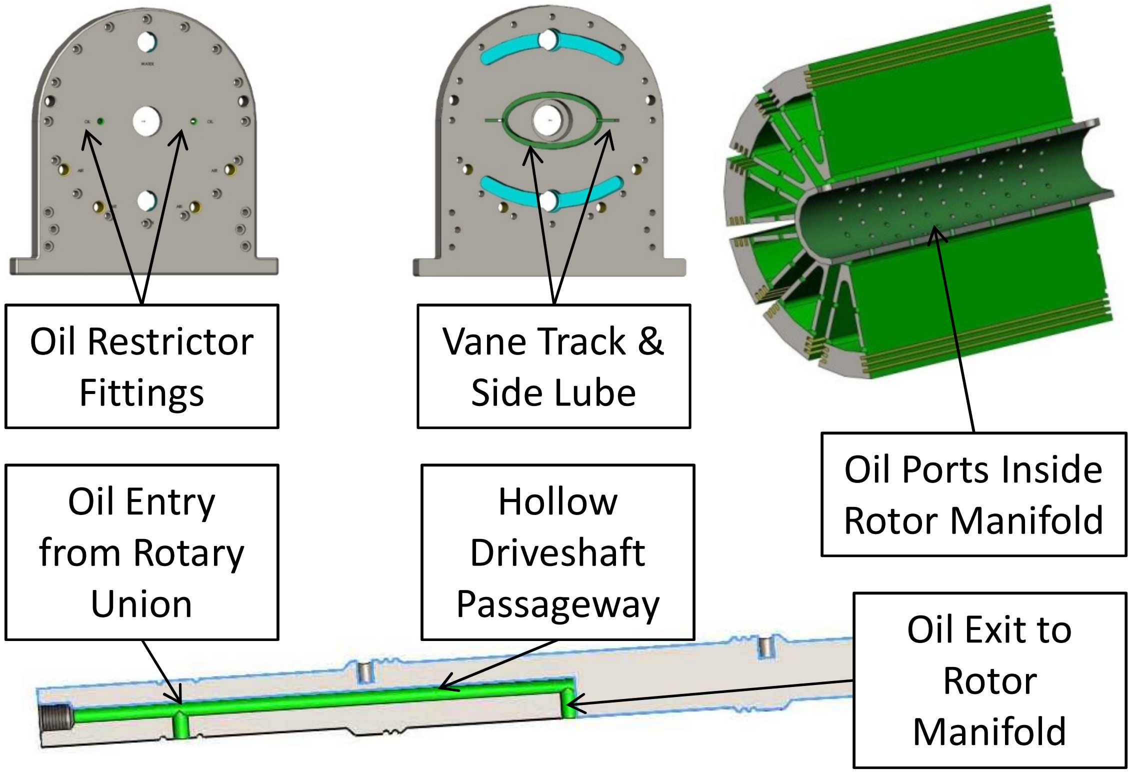


The Circle Ellipse Engine Rotor turns inside the Elliptical Housing forming four expanding-contracting regions. These directly correspond to the four-stroke Otto Cycle.

Circle Ellipse Engine

Evolutionary, Lightweight, Symmetrical, Scalable, 5 Major Parts

LUBRICATION OIL enters the engine through 6 restrictor fittings, which limit and control volume. There are two fittings on each end plate, which lubricate the vane track and the sides of the vanes. The housing has two restrictor fittings on opposite sides of the housing, which lubricate the surface of the apex seal.

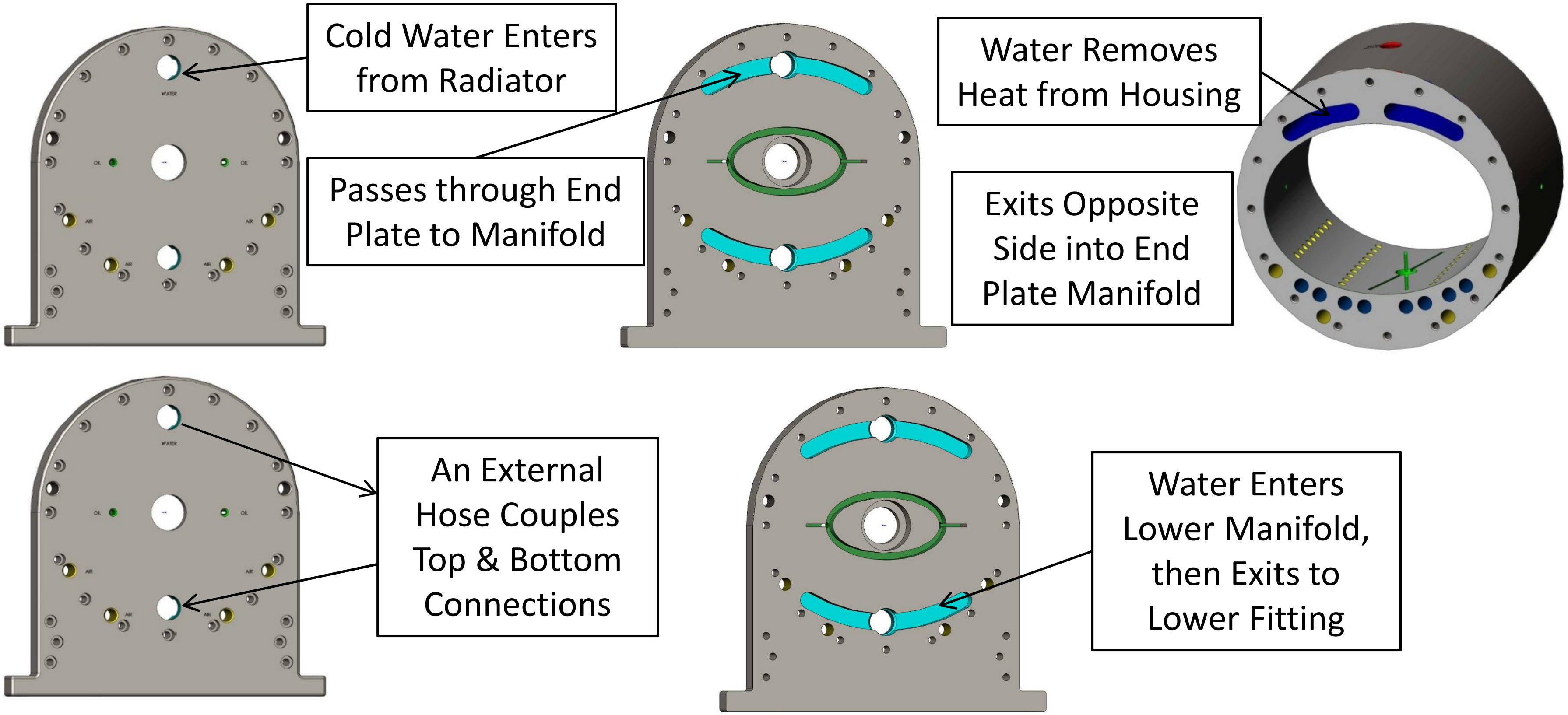


Cooling Oil enters the engine through the rotary union, passes through the hollow driveshaft, and exits into a manifold in the rotor. From there, distributed ports allow oil to flow into the rotor to lubricate the vanes, apex seals, and remove heat. A sump drain is located in the bottom of the housing to evacuate excess oil every revolution, which is de-foamed, filtered, and returned.

Circle Ellipse Engine

Evolutionary, Lightweight, Symmetrical, Scalable, 5 Major Parts

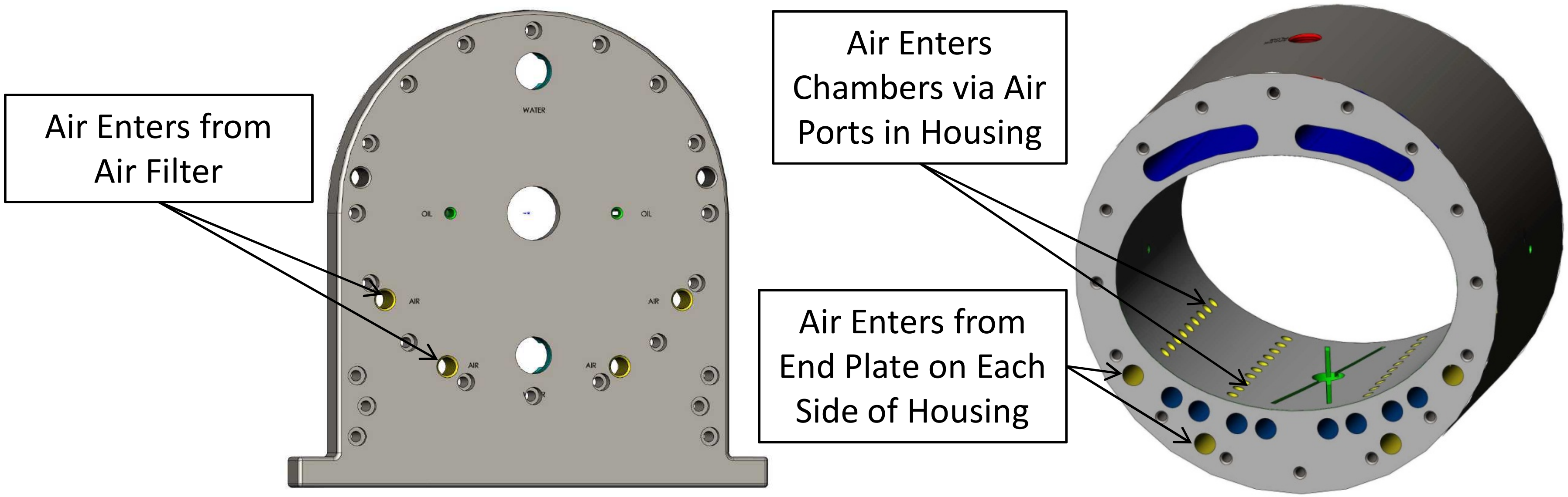
COOLING WATER enters through a large brass fitting on the end plate. The inside of the end plate is a water manifold, which connects water for passage through the housing. The opposite End Plate water fittings are connected with hoses. The lower water port returns water to the radiator and water pump.



Circle Ellipse Engine

Evolutionary, Lightweight, Symmetrical, Scalable, 5 Major Parts

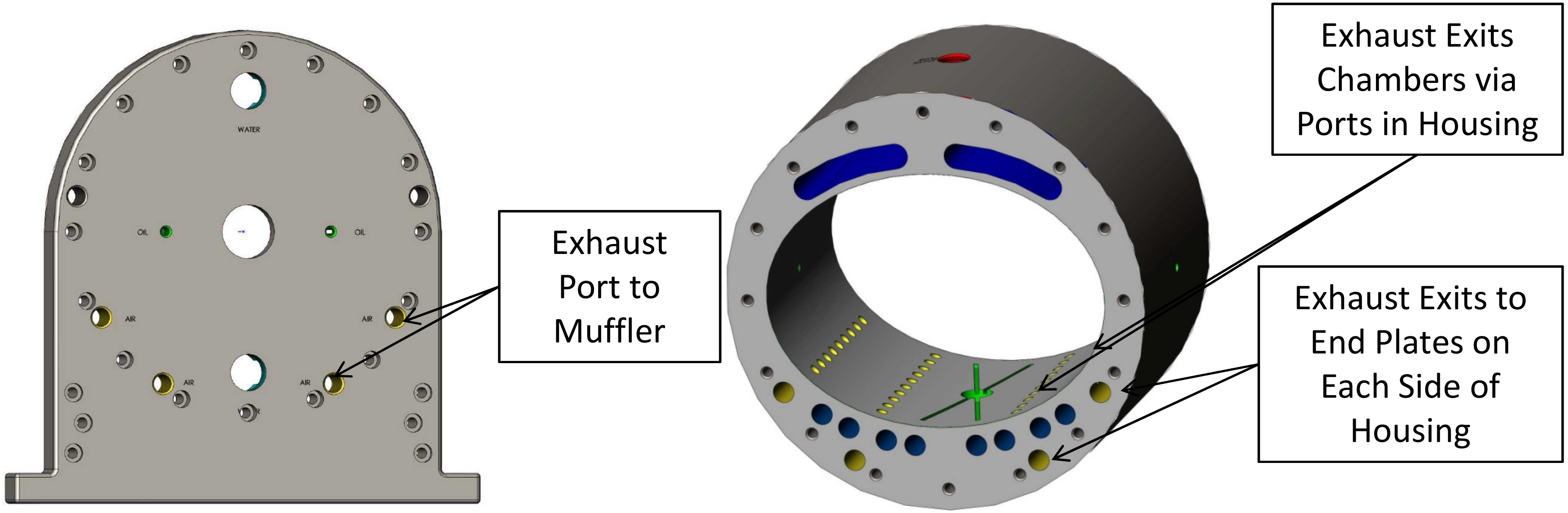
CLEAN, FILTERED AIR enters through two steel fittings on each of the end plates. These are aligned with passageways in the housing. Air is guided into chamber space between the housing and rotor through two lines of strategically placed ports. These allow the air to enter the rotor during the intake (expansion) portion of the Otto Cycle successively for each of the 12 Chambers.



Circle Ellipse Engine

Evolutionary, Lightweight, Symmetrical, Scalable, 5 Major Parts

EXHAUST products are expelled during the exhaust portion of the Otto Cycle. The exhaust is allowed to enter the housing through two lines of strategically placed holes, which in turn lead to ports on each side of the housing. These ports align with similar ports on each end plate. From there, exhaust is coupled by hoses to a muffler, and other treatment hardware if needed, such as a catalytic filter, resonator, or for a Diesel engine, urea filter.



Circle Ellipse Engine

Evolutionary, Lightweight, Symmetrical, Scalable, 5 Major Parts

Circle Ellipse Engine Summary

Advantages

- Smaller Size & Weight Compared to Reciprocating Engine of same Power
- Only two major moving parts — rotor and vanes
- Rotor partitioned into 12 chambers
- No valves — fuel and exhaust enter & exit similarly to two-cycle engine
- Fires continuously every revolution in each chamber
- Runs at half the RPM than a similar power Reciprocating Engine

Disadvantages

- Rotary Engine Reputation - high oil usage, pollutants, and limited durability.
- Historical Issues - lubrication, cooling, sealing, thermodynamics, & mechanical

Solutions Implemented in Circle Ellipse Engine Design

- Lubrication – Strategically located oil ports managed by flow restrictors
- Cooling – High flow water jacket provides thermal stability
- Sealing – Solutions adopted from successful Mazda implementation of Wankel
- Thermodynamics – Integrates proven fuel and air management from successful engines
- Mechanical interfaces – Friction minimized using proven material selection & coatings