Alternatives to the Piston IC Engine

By:
Juan Gonzalez
Andrew Zwolinski

Outline

- History of the IC engine
- Alternatives to the IC engine
- Closer look at the Rotary Engine

History of the IC Engine

- 1673

  Christiaan Huygen made the first piston mechanism.

  Utilizing gunpowder as reactant.

History of the IC Engine

- 1695

  Denis Papin

  Invented pressure cooker.

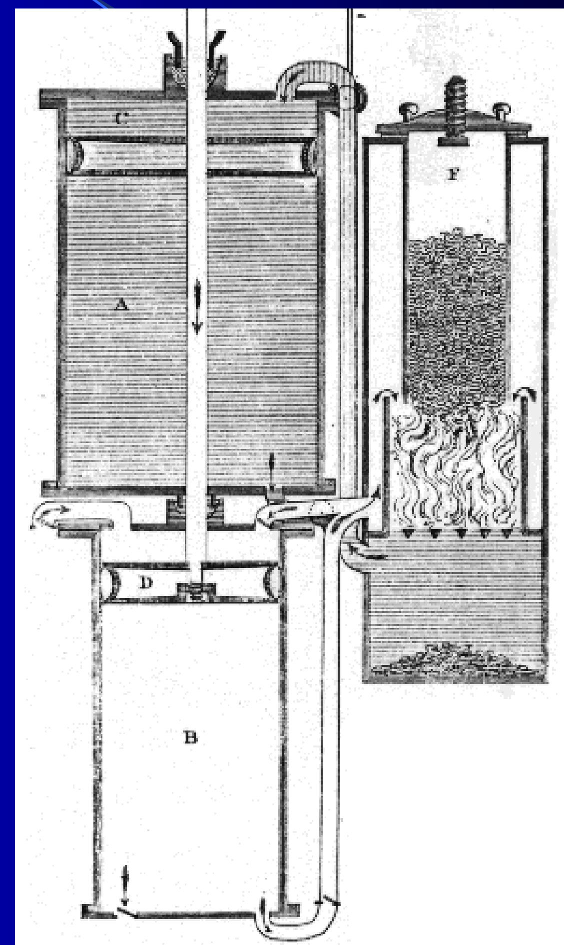
  First to utilize steam in a piston mechanism.

History of the IC Engine

- 1807

  Sir George Caley

  First to utilize air as the expansion gas.



History of the IC Engine

- Jean Joseph Etienne Lenoir- 1860

  First Production IC Engine.
- Nicolaus Otto- 1877

  4 Stroke engine design patented.
- Daimler/Maybach- 1882

  Incorporated IC engine in automobile.

IC Engine Altenatives

- Stirling Engine
- Two Stroke
- Turbine
- Quasiturbine
- Rotary

IC Engine Alternatives

- Stirling Engine, 1816 Rev. Robert Stirling

  Not an IC engine

  More Expensive and complicated

  Cooling system twice the capacity of Diesel for same power

  Down Time, has to “Heat up”

IC Engine Alternatives

- Two Stroke, Dugald Clerk, 1877
  Made initial push toward engine.
- Currently SAAB is working on R&D.
- Problems with combustion products limits use.

IC Engine Alternatives

- Turbines

  Principal idea from John Barber 1791

  Big 3 have been experiment on and off since 1940.

  Turbine stress is the major obstacle.

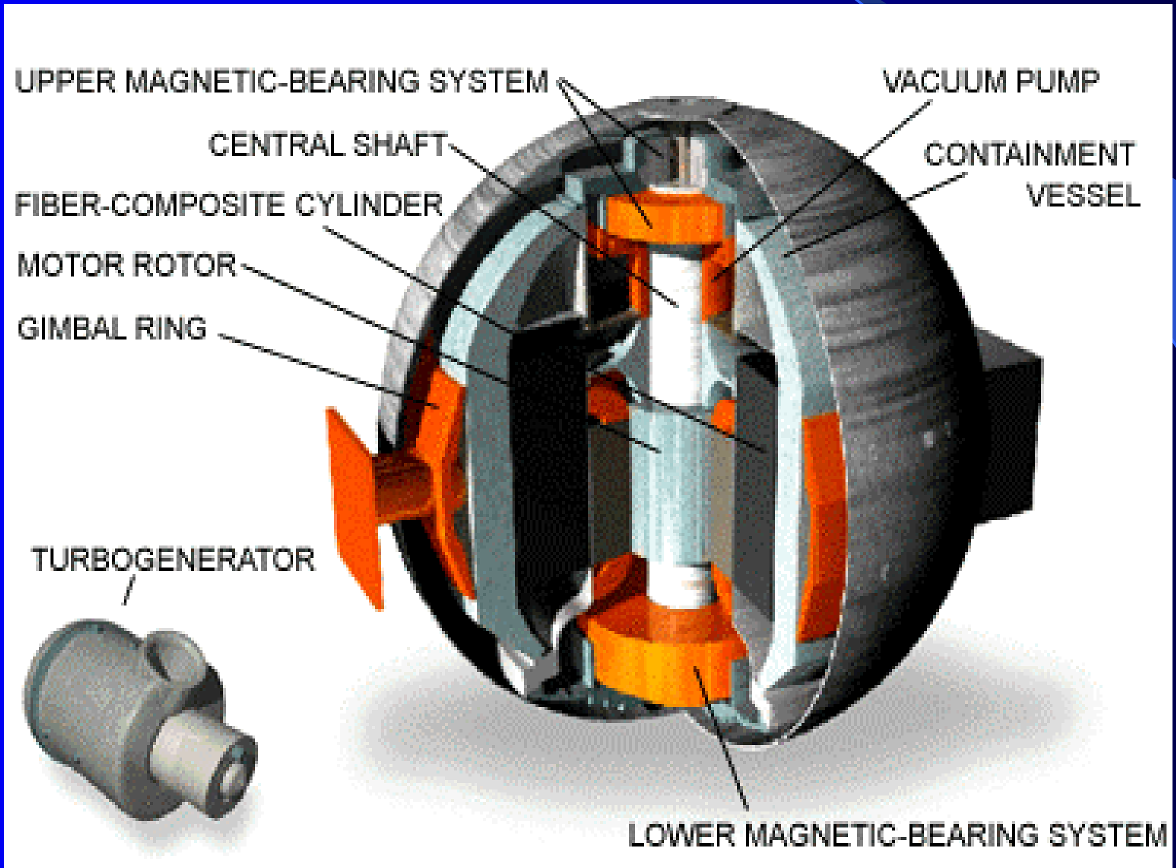
IC Engine Alternatives

- Turbines

  Current ceramic technology able to overcome past obstacles.

  The Office of Advanced Automotive Technologies is evaluating the turbine further.

IC Engine Alternatives



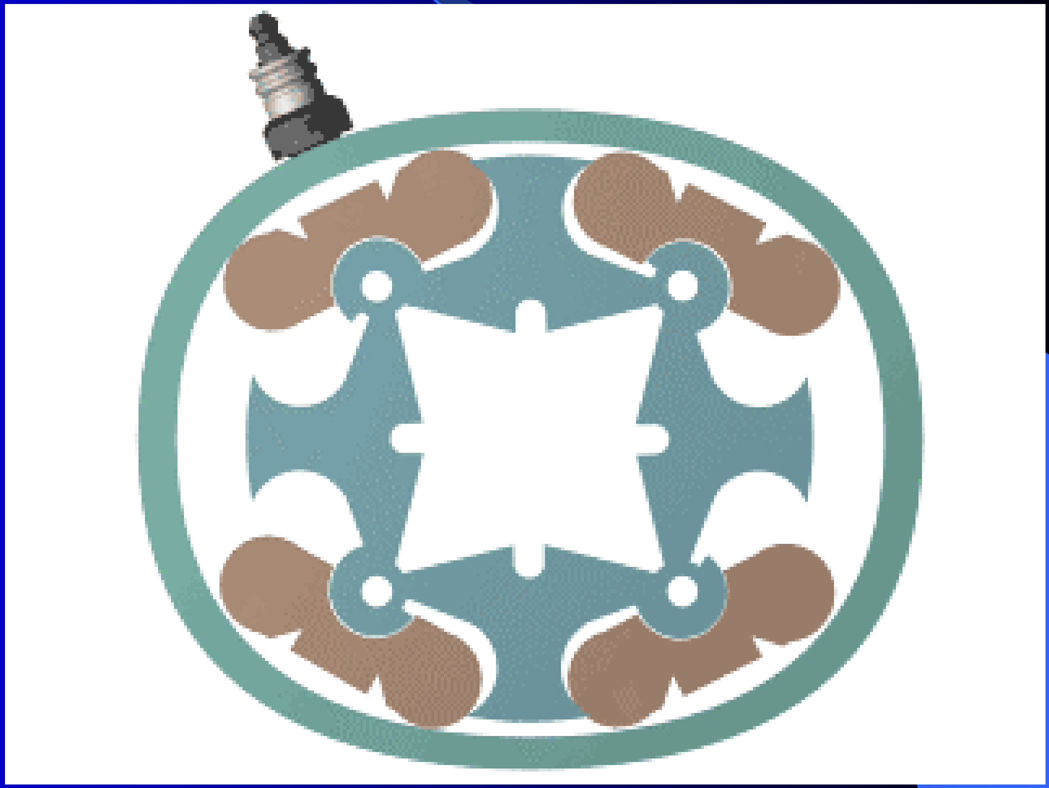
IC Engine Alternatives

- Quasiturbine

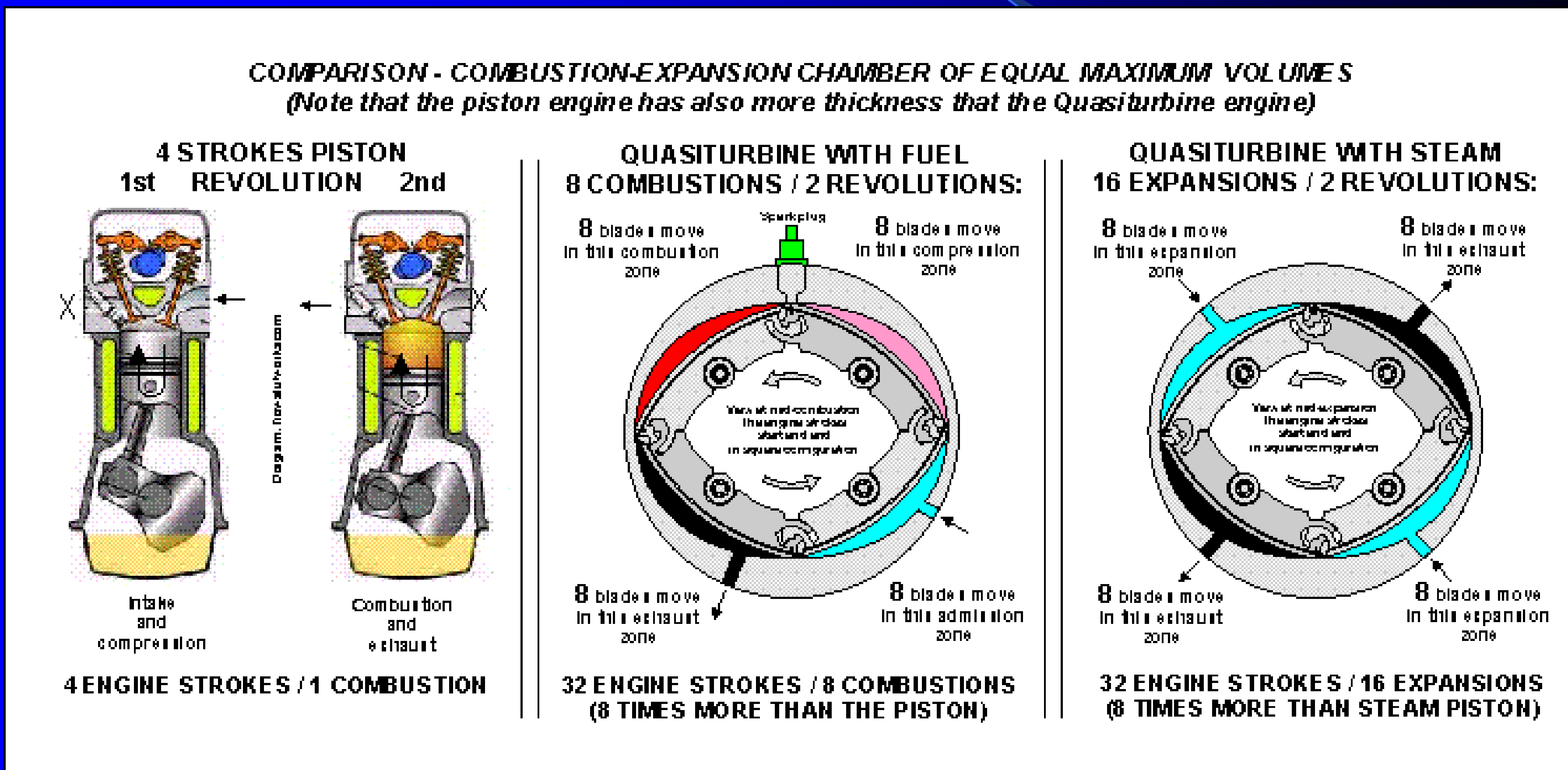
  Invented in Quebec

  Currently under development and commercially not viable yet

Link



IC Engine Alternatives



IC Engine Alternatives

PISTON - WANKEL - QUASITURBINE

(Theoritical values not experimentally verified)

	Volume of each chamber (Prototype 1999)	Number of expansions (combustions) in every " 2 " revolutions	Power multiplyer (substained pressure)	Relative power (same RPM)
Piston 4 strokes (gazoline)	50 cc	1	1	1
Piston 2 strokes (gazoline)	50 cc	2	1	2
Wankel 4 strokes (rotor - not shaft)	50 cc	6	0.4 to 0.7	4
Qurbine 4 strokes (gazoline)	50 cc	8	1.2	10
Qurbine 2 strokes (gazoline)	50 cc	16	1.2	20
Qurbine (Steam / pneumatic) (500 psi)	50 cc	16	2.5	40

IC Engine Alternatives

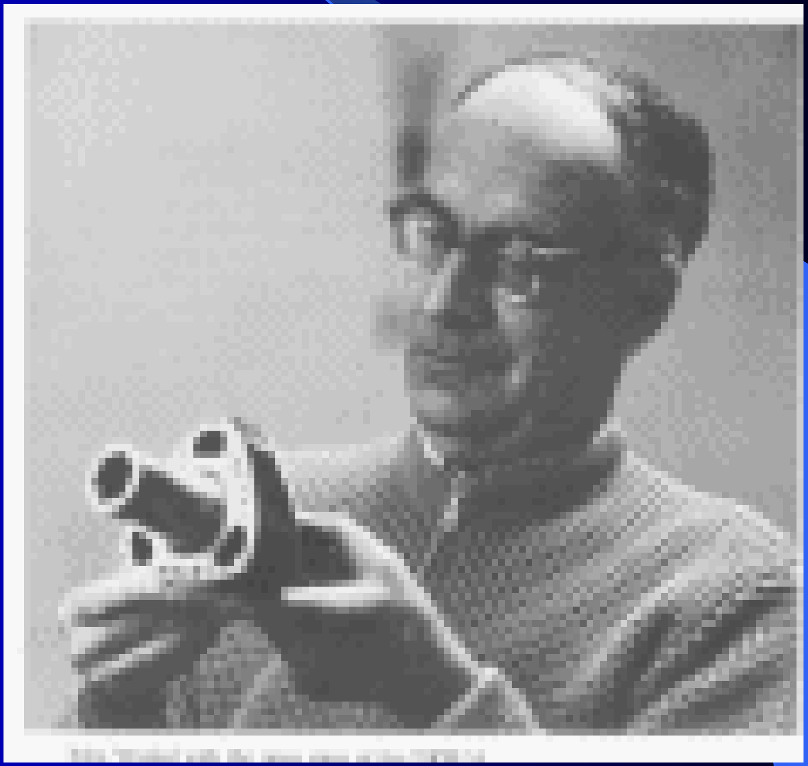
- Wankel Rotary Engine

  Felix Heinrich Wankel

  Sketched in 1924

  Prototype 1929

  Patented double rotor 1934

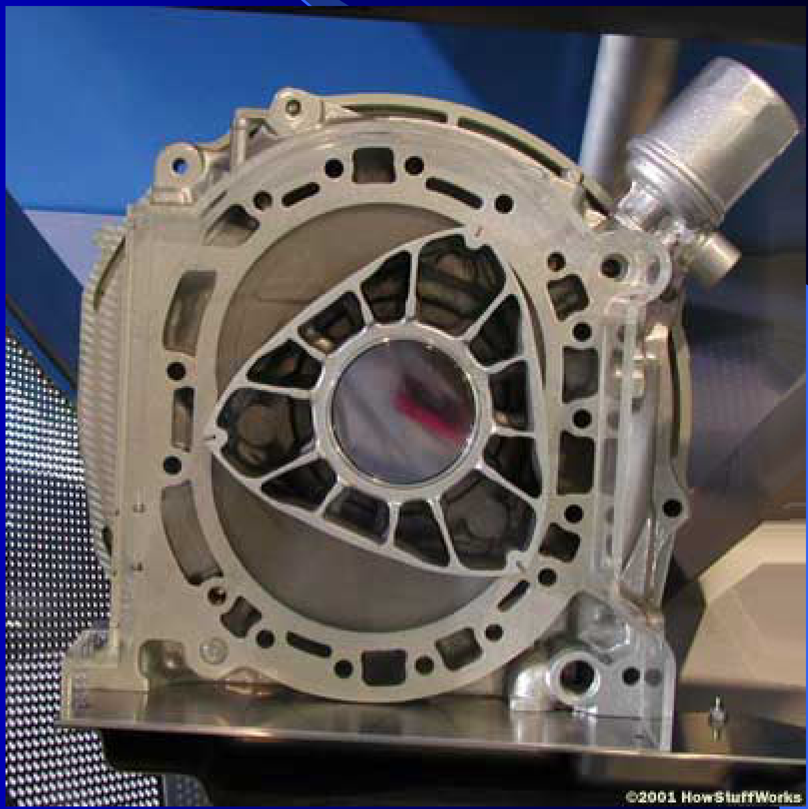


Overview

- RCE engines are Otto Cycle engines. (4 phases in combustion cycle)
- Compression is achieved by volume reduction.
- There are three separate volumes of gas at any point.

Overview

- In a piston engine the same volume of space does four different jobs (intake, compression, combustion and exhaust).
- A Rotary engine does the same four jobs in separate parts of the housing.



Types of RCE

KKM or planetary rotation motor

- Stationary peripheral housing.
- Rotor moves in an orbit and propels an eccentric shaft.
- Better cooling.
- More compact.
- Easier to manufacture.
- Modern RCE engines are KKM.

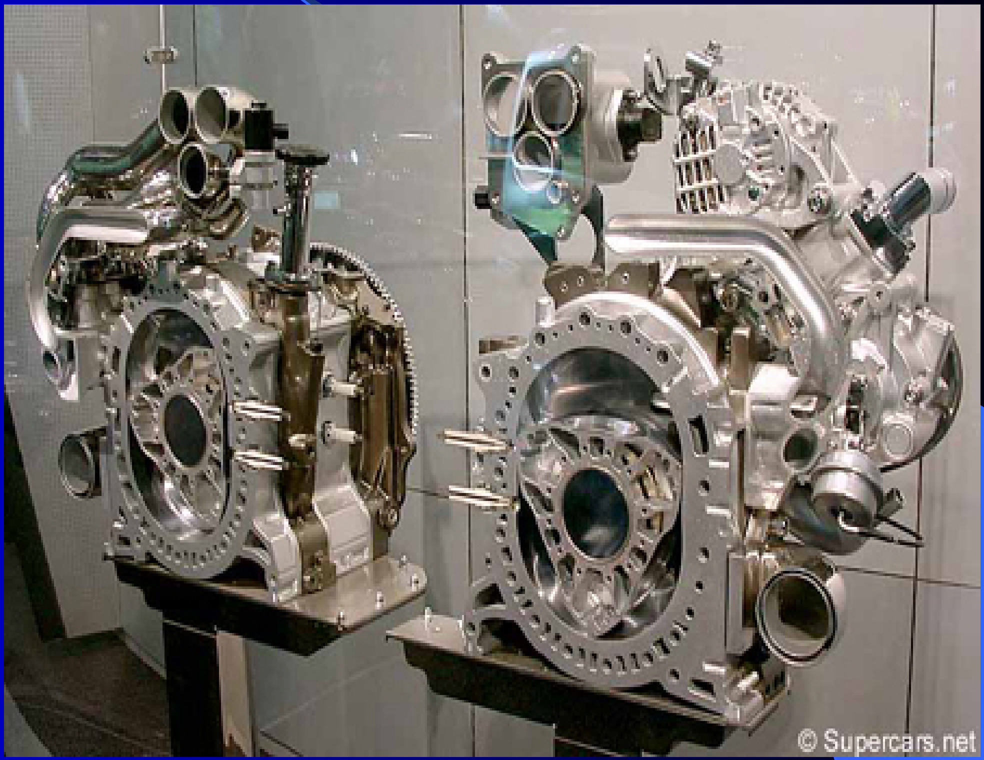
DKM or single rotation engine.

- The first RCE
- Central fixed shaft
- Inner rotating housing and rotor moving around the shaft.
- Smoothest of the two.
- Engine disassembly required to change spark plugs.
- 25000 RPM or above are possible.
- No longer in use.

Parts

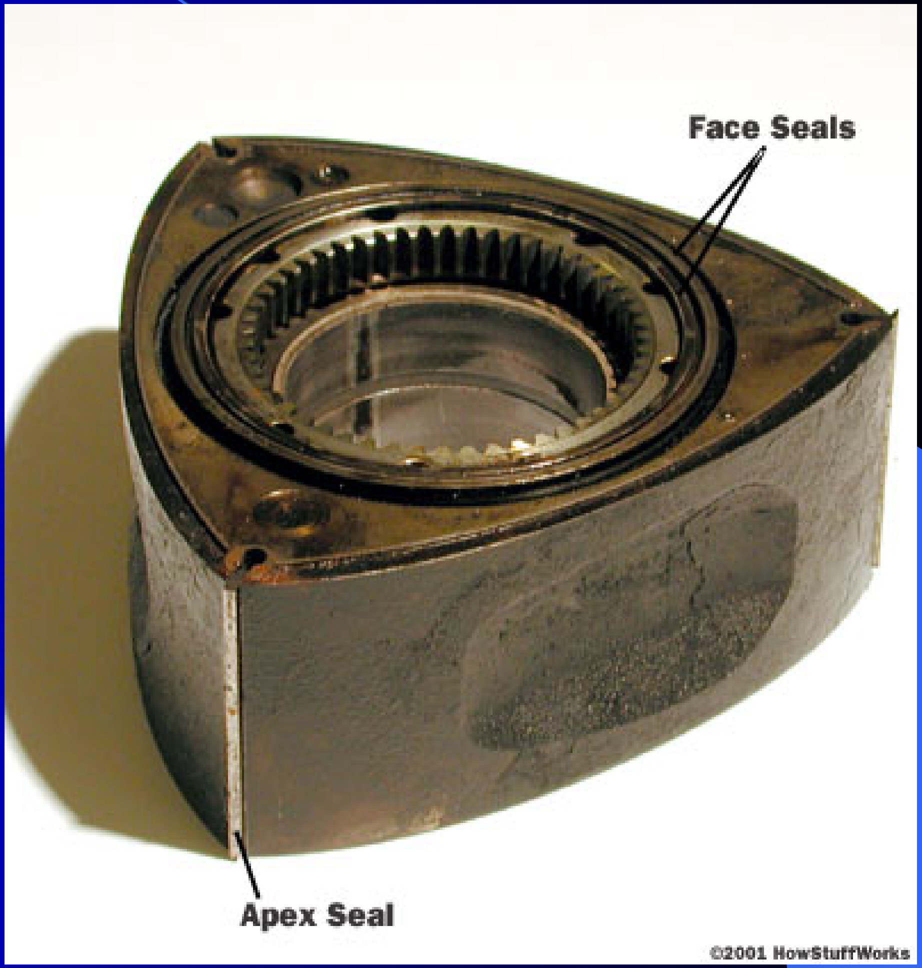
- Rotor
- Housing
- Output Shaft.
- Intake and exhaust ports

demo



Rotor.

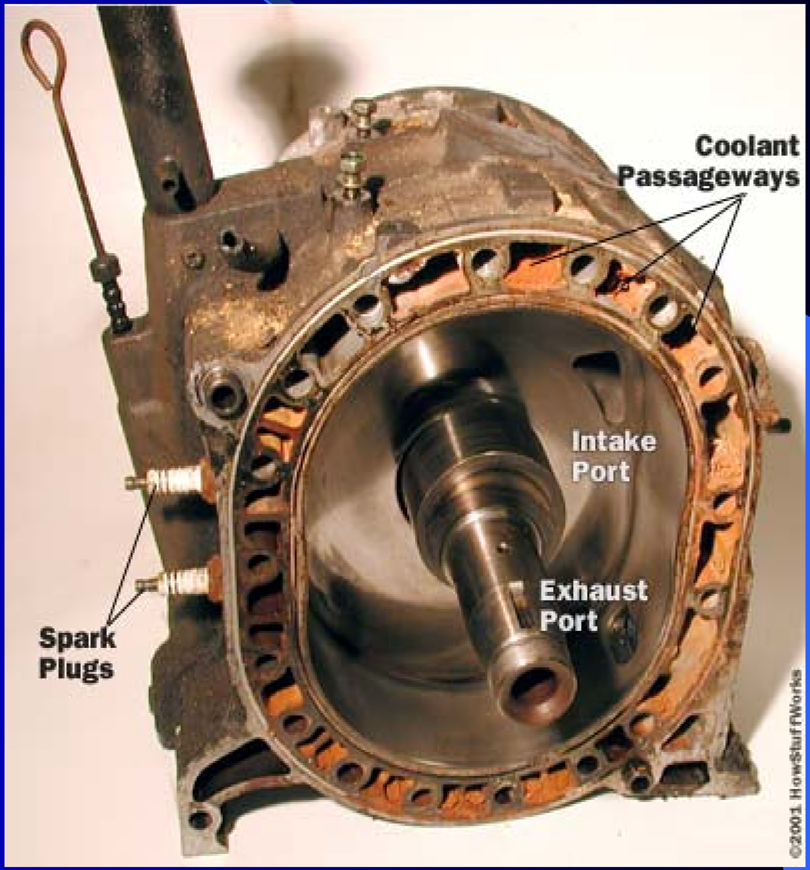
- RCE Rotor supercedes the piston engine's reciprocating piston.
- Has three convex faces each acting like a piston.
- Metal blade at apex of each face forms seals of the combustion chamber
- Teeth at the center of the rotor connect to output shaft.



Housing

- The housing is epitrochoid in shape.
- Designed to keep all three tips of rotor in contact with housing at all times.
- Creates three separate volumes of gas at any time during rotation.
- Housing is designed with four parts specifically dedicated to one of the following:

  Intake,compression, combustion and exhaust.

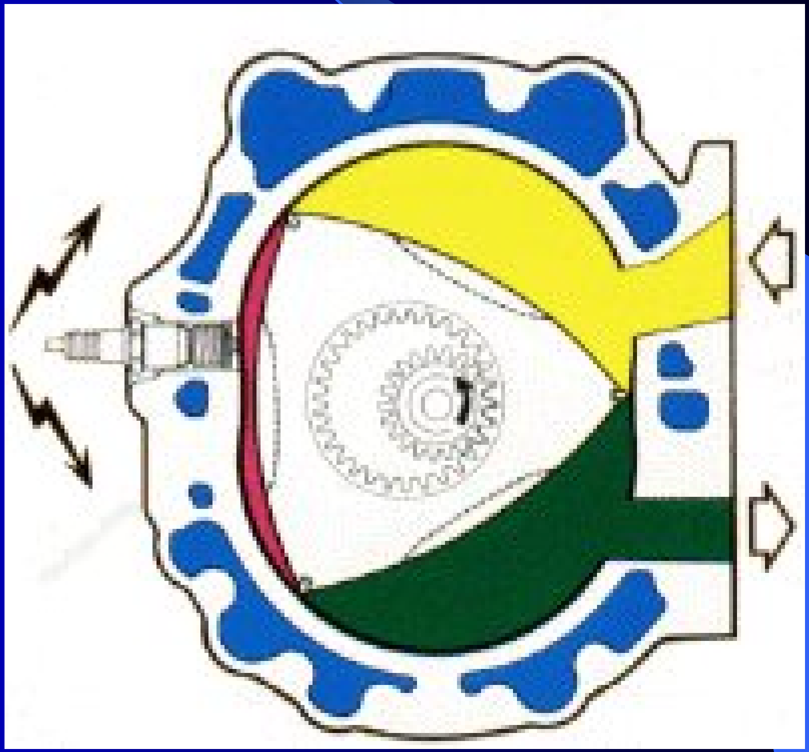


Output Shaft

- Output shaft has lobes mounted offset from the centerline of the shaft. Rotors are mounted on these lobes.
- Each lobe acts as a crankshaft on the piston engine.
- When rotor follows the surface of the housing it creates torque on the lobes making the output shaft rotate.

Intake and Exhaust Ports

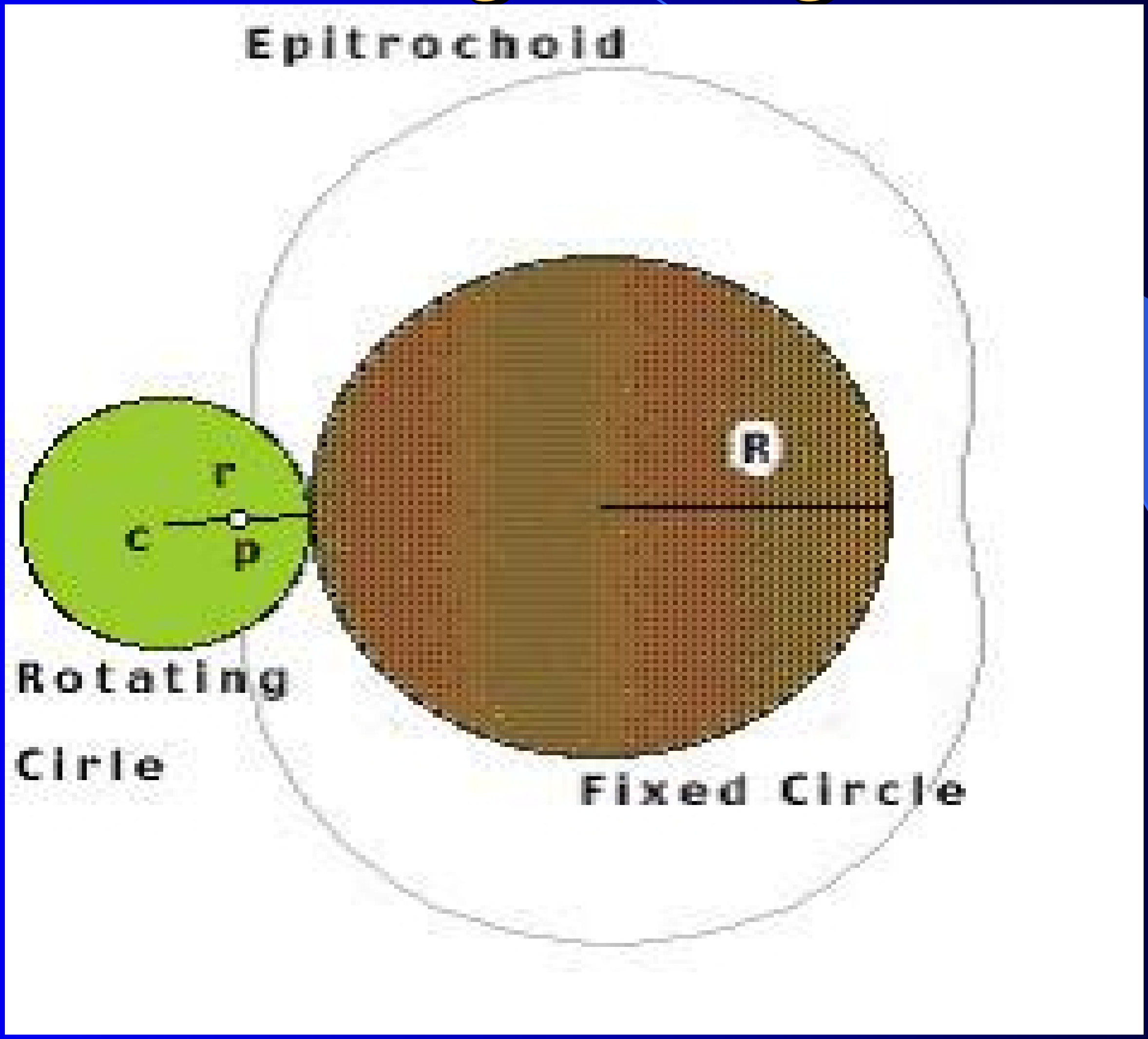
- Ports are created in the housing eliminating valves, camshafts, cams, lifter rods and timing belts.
- Rotary engines have 4 or 6 ports for intake and exhaust.
- 6 port rotary engines use one extra intake port per rotor used only at higher RPM'S.



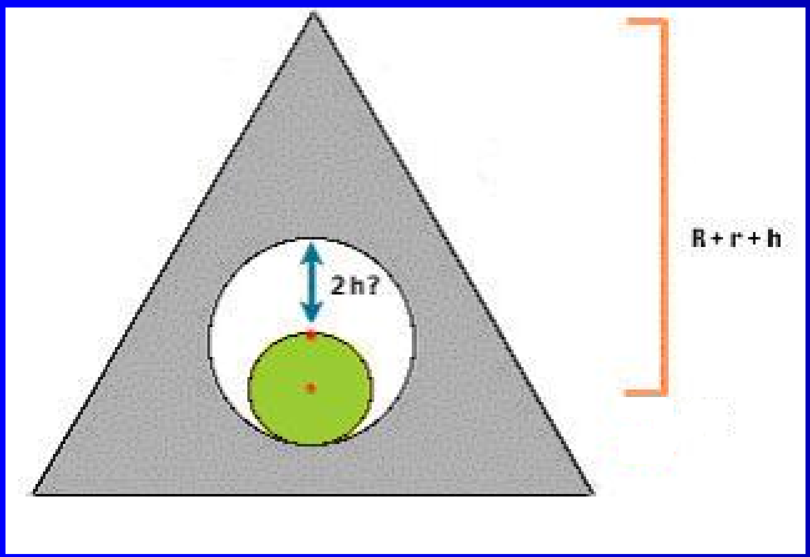
How it Works

Demo2

Housing Design.



Housing design Cont.



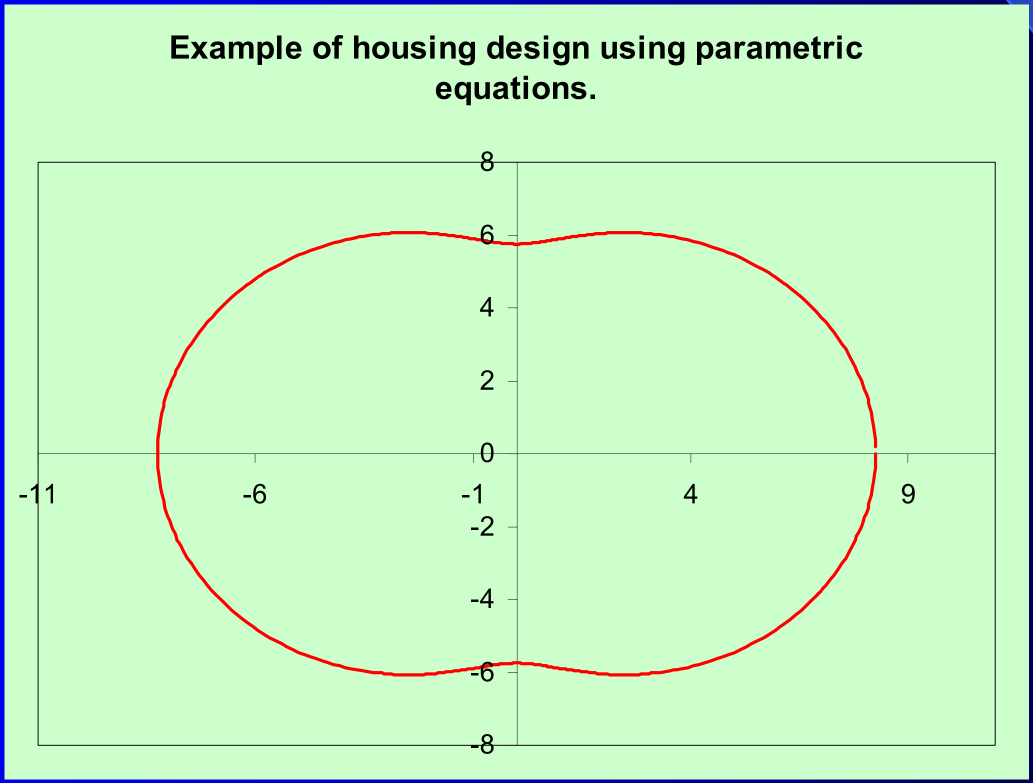
- Parametric equations:
- X=e*cos3A+BcosA
- Y=e*sin3A+BsinA

Where A is angle (rad), B is distance from center of triangle to apex and e is eccentricity.

Demo3

Housing Design Cont.

Example of housing design using parametric equations. r=2.5, R=4.5



Compression ratio

$$C_R := \frac{\frac{A_{max}}{B^2}}{\frac{A_{min}}{B^2}}$$

Compression Ratio Cont.

$$\frac{A_{max}}{B^2} := \pi \cdot \left[\left[\left(\frac{\varepsilon}{B} \right)^2 + \frac{1}{3} \right] \right] - \frac{3^{0.5}}{4 \cdot \left[1 - 6 \cdot \left(\frac{\varepsilon}{B} \right) \right]}$$

$$\frac{A_{min}}{B^2} := \pi \cdot \left[\left[\left(\frac{\varepsilon}{B} \right)^2 + \frac{1}{3} \right] \right] - \frac{3^{0.5}}{4 \cdot \left[1 + 6 \cdot \left(\frac{\varepsilon}{B} \right) \right]}$$

Compression Ratio Cont.

Compression Demo

Displacement

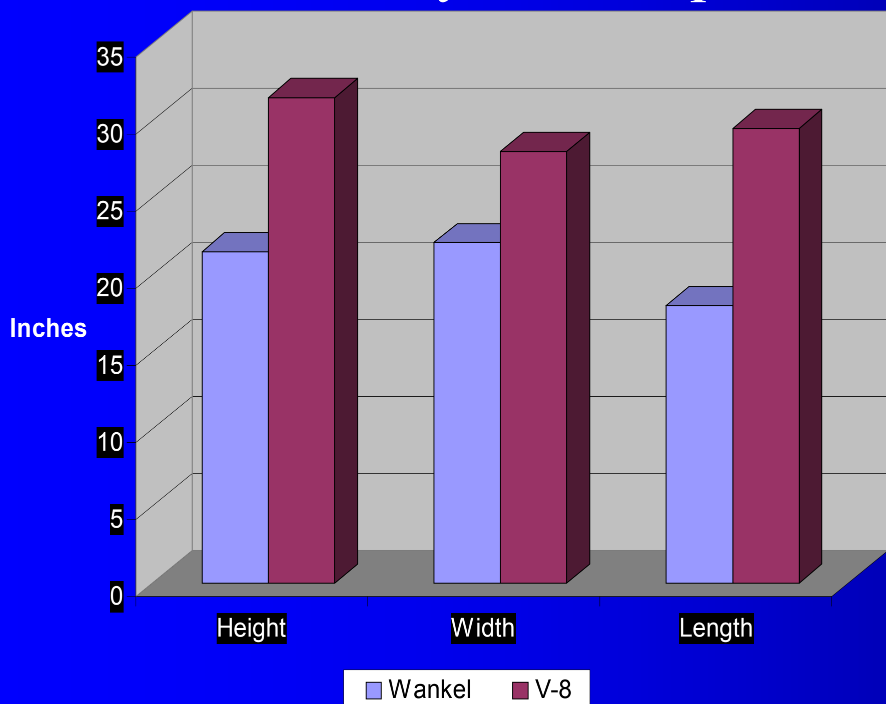
$$D := 3 \cdot 3^{0.5} \cdot W \cdot B^2 \cdot \left(\frac{\varepsilon}{B}\right)$$

Key Differences

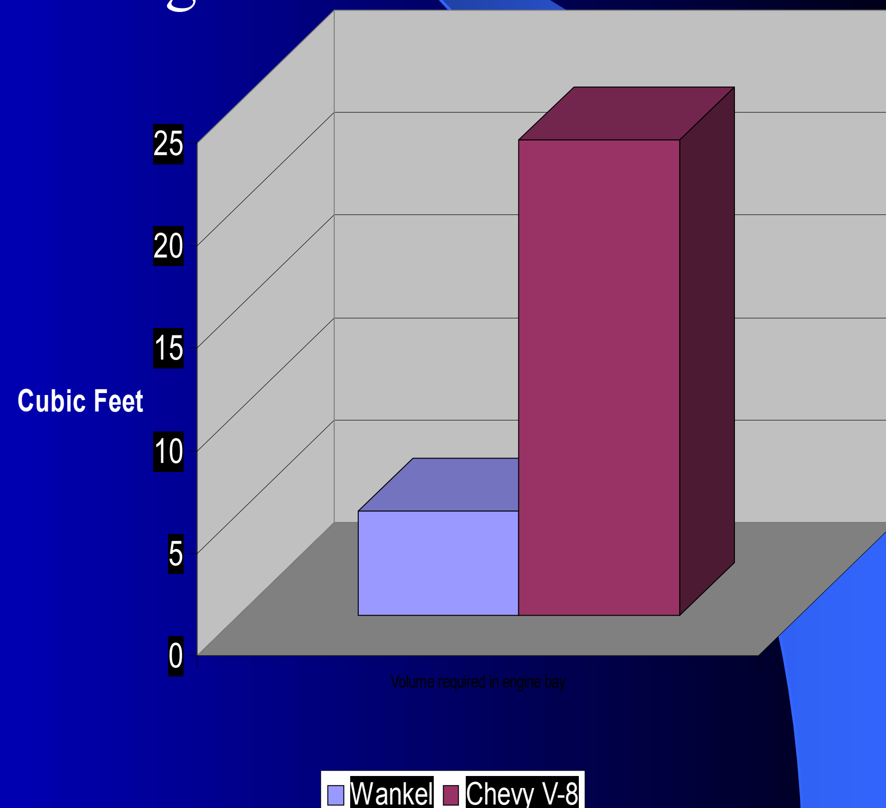
- Fewer moving parts
- Better reliability
- Smoother
- Slower moving parts

Engine Comparison

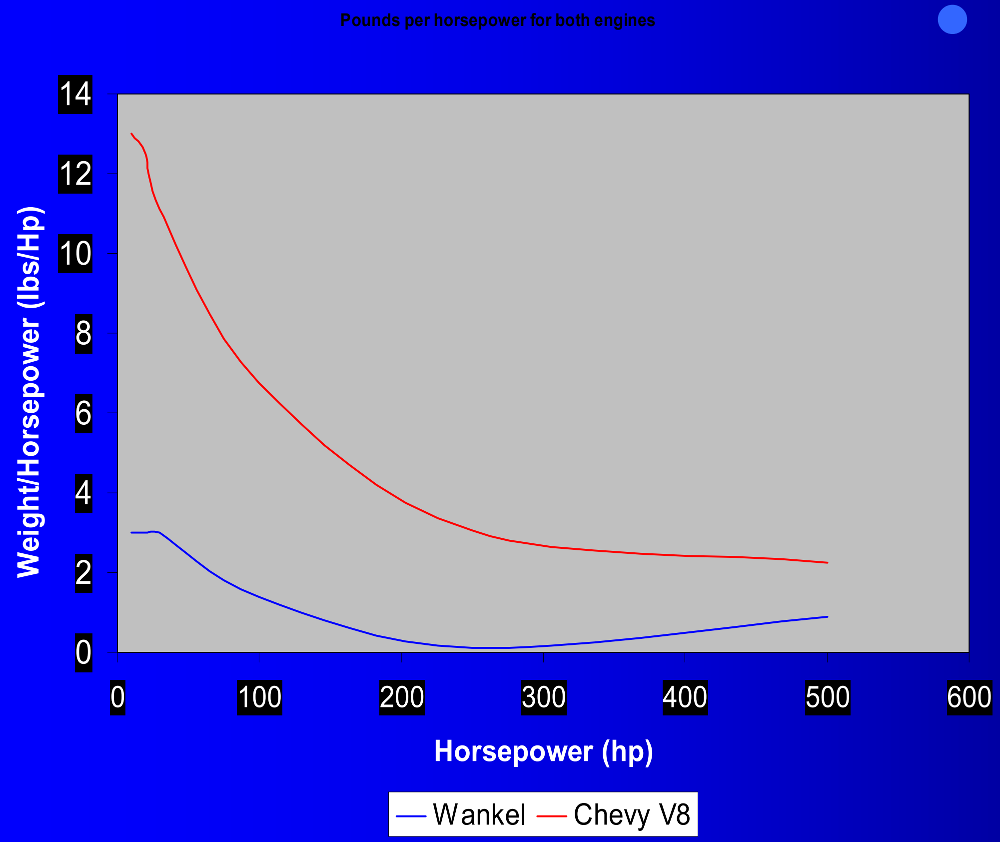
- Overall dimensions of Wankel RC2-60 u5 engine and Chevy 238 V8 piston



- Volume required to accept engine and all accessories.



Weight Vs power



- Comparison of same two engines from before. Weight vs Horsepower ratio shows lower weight for wankel engine throughout the band.

Challenges

- Harder to meet US emissions
- Higher manufacturing costs
- More Fuel consumption
- Low compression ratio

Cars with rotary engines

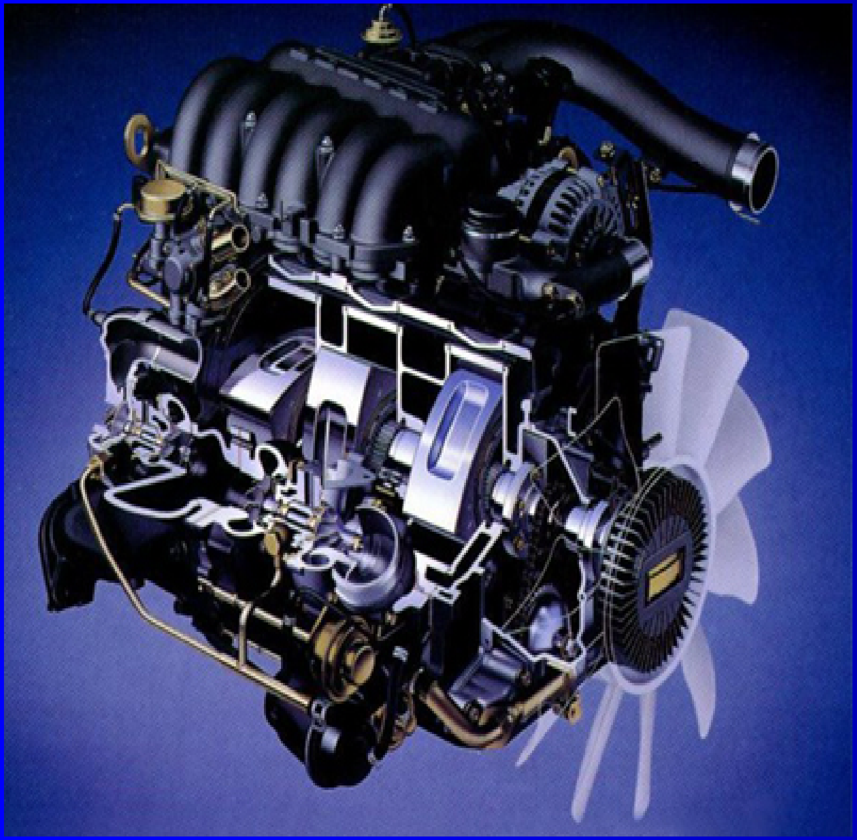
- Rx-2

- RX-7

- RX-5

RX-8

Future Of RCE Engines



- New triple rotor engine in development by Mazda Corp.

Mazda Rx-8

Renesys improvements:

- Position intake and exhaust ports on side housing separate from rotor housing.
- Reduces overlap and increases port size.
- 3 port, 3 stage variable intake system.
- 250 hp normally aspirated

End Of Presentation

Thank You.