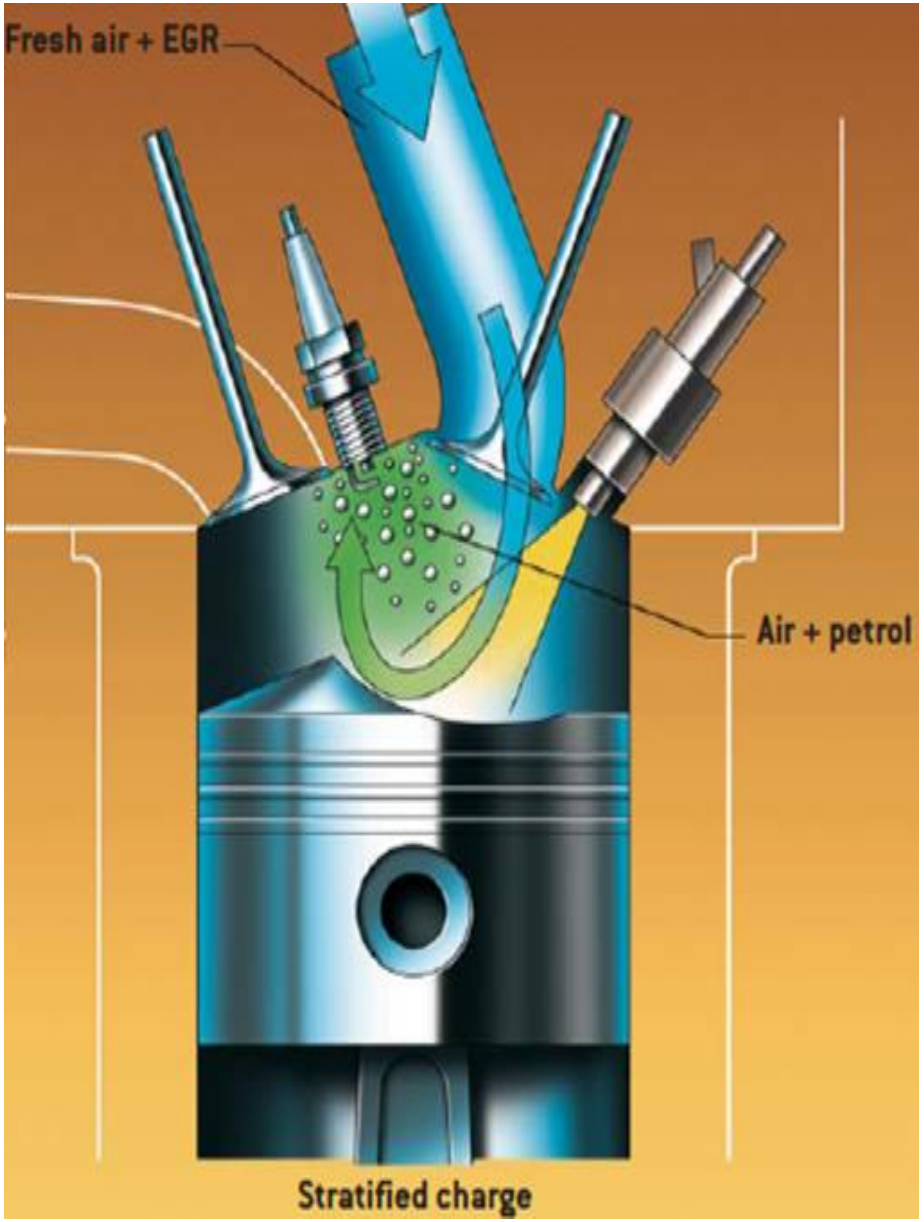
Direct Ignition Stratified Charge Engine

SI Engines	CI Engines
Good full load characteristics High degree of air utilisation High speed etc.	Poor full load characteristics Poor air utilisation (20-40% excess air even at full loads)
Poor part load characteristics Since o/p is controlled by throttling the air fuel mixture. F/A ratio remains almost constant at all loads. That has several disadvantages 1. ϒ is closer to 1.3 (for stoichiometric mixture) thereby reducing efficiency. 2. Peak T & P at all loads thereby increasing effects of variation of specific heats, dissociation and heat losses.	Good part load characteristics. Since o/p is controlled by metered fuel injection. F-A mixture becomes even leaner at part load. That has the following advantages 1. ϒ is closer to 1.4 as mixture becomes leaner (ϒ=1.4 for air) thereby increasing efficiency. 2. Less than peak T & P at part loads due to lean mixture.
Low compression ratio	High compression ratio 1. High efficiency 2. Better starting and combustion 3. But high maintenance, weight to power ratio and losses.
For Automobile engines 90 % of total operating life under part load condition. But maximum power o/p controls the speed, acceleration and other characteristics.	
Thus an ideal engine has good part load characteristics and full load characteristics. Greater compression ratio than SI engines to have higher efficiency. Lesser compression ratio than CI engines for it to be compact and to limit losses.	
The solution is Stratified Fuel injection SI engines. Without stratification fuel injection will lead to lean mixtures and thus misfire.	

DEFINITION

- IC engine in which air-fuel ratio isn't equal throughout the cylinder.
- Rich mixture is provided close to the spark plug and combustion promotes ignition of a lean mixture in the remainder of the cylinder.
- Stratified charge is a process for petrol engine. It is similar in some ways to the Diesel cycle, but running on normal gasoline.


Fresh air + EGR
Air + petrol
Stratified charge

WORKING

- Input of air is such that it generates a swirl in the cylinder.
- In a stratified charge engine, the fuel is injected into the cylinder just before ignition. This allows for higher compression ratios without "knock," and leaner air/fuel mixtures than in conventional internal combustion engines.
- As the fuel is ignited and burned, the surrounding air provides almost complete combustion before the exhaust port opens which further burns the lean mixture.

ADVANTAGES

1. The overall air-fuel ratio can be very lean reaching 40:1 to 50:1 giving high fuel efficiency.
2. The mixture being rich near spark plug, good ignition characteristics without misfire are obtained.
3. The end gases being very fuel lean, pre-combustion reactions would be very slow leading to reduced knocking tendency. Hence, a higher compression ratio can be used further improving the fuel efficiency.
4. Presence of rich mixture near spark plug keeps the formation of NOx at low levels. The mixture that burns early is deficient in oxygen although it attains high combustion temperatures. Also less HC emissions due to less flame quenching at cylinder walls since very lean mixture near walls.

DISADVANTAGES

- Injectors add significant cost to the system but fuel efficiency advantages are overcoming this.
- With increasing load, the efficiency matches with that of conventional engines due to stoichiometric mixture.
- High cyclic variability can disrupt the formation (and location) of the stratified areas, reducing the effect of the spark - if the rich area is not near the spark then combustion either may not occur properly.

Wankel or Rotary engine

History

- Ideas have existed since the 16th century
- German scientist Felix Wankel was the first to put the idea into a working design
- Mazda produced its first rotary power car in 1961 and created their Rotary Engine Division in 1963

- Popularity for the rotary powered vehicles increased rapidly until the gas crisis in the mid 70's
  - Rotary engines were not very fuel efficient compared to piston engines
  - Strict emissions standards could not be met with current rotary technology
- These two factors severely hurt the sale and development of rotary engines

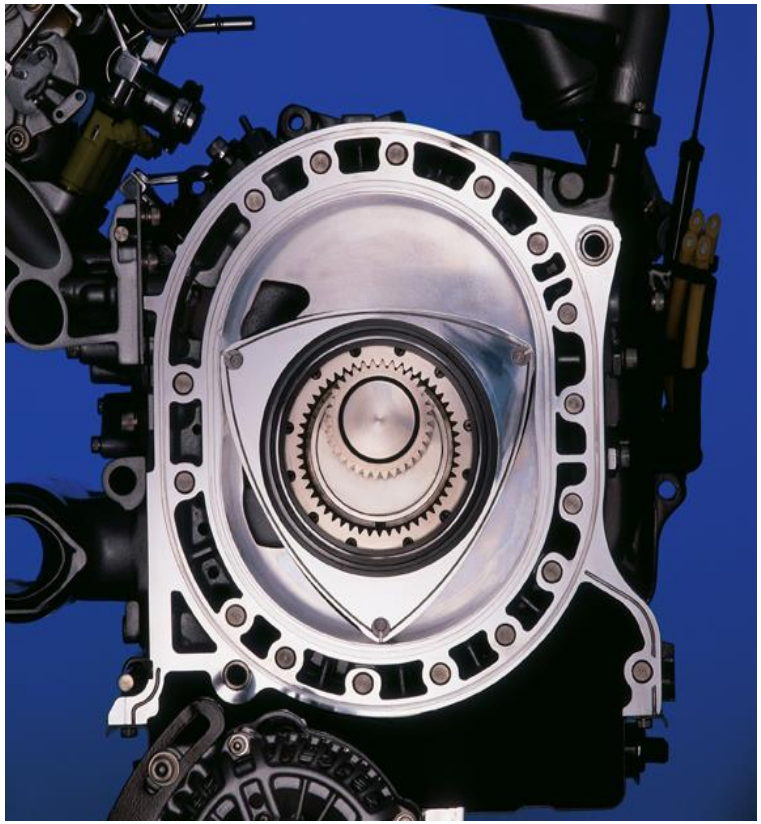
- Mazda was the only car company that continued to produce cars with rotary engines through the 90's

Automotive Success with Rotaries

- In 1991, the Mazda 787B won the 24-hour Le Mans endurance race
  - Rotary engines were then banned from the C2 circuit
- The RX-8 is able to produce 238 hp from its 1.3L engine and with good gas mileage and favorable emissions

How It Works

- Triangular Rotors used instead of pistons
- Rotor that spins in an oval chamber by burning fuel.
- Rotor has three lobes.
- Rotor rotates in an eccentric pattern
- The lobes remain in contact with the oval housing, creating a tight seal.
- Intake/exhaust ports are located in the side walls of the housing instead of using valves
- Torque is transmitted via the ring gears inside each rotor



The Cycle

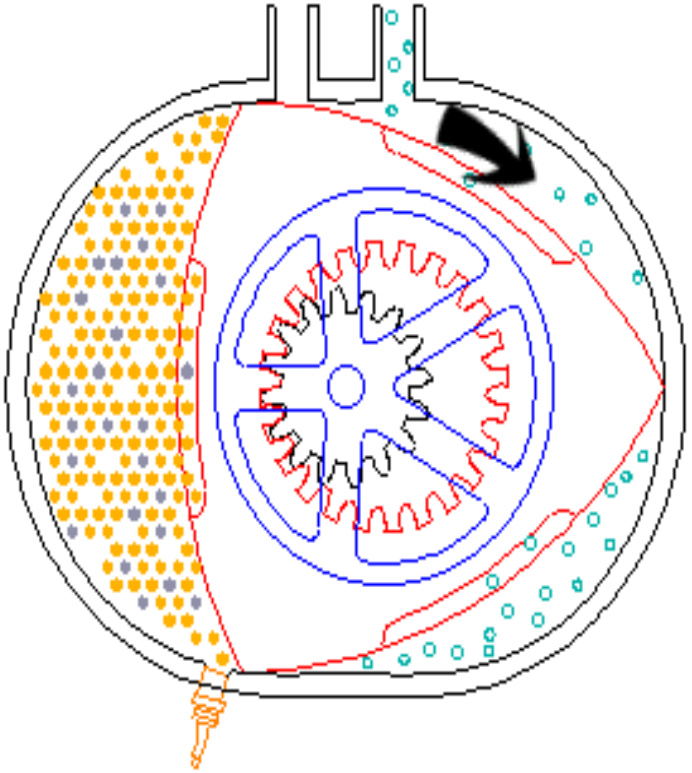
Intake stroke

•The fuel/air mixture is drawn in the intake port during this phase of the rotation.

•Begins when apex passes intake port

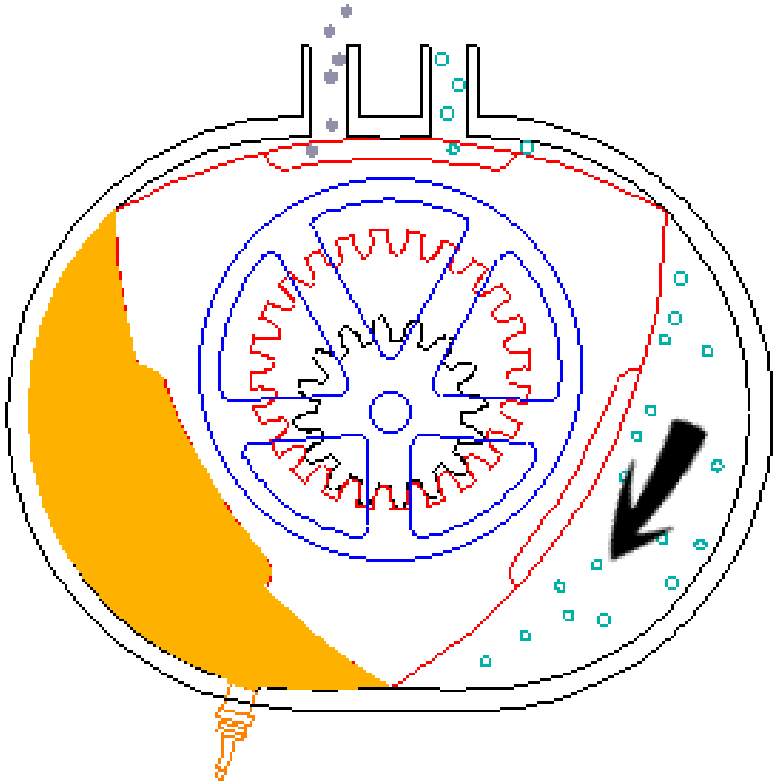
•Increase in chamber volume

•Completes when next apex passes intake port



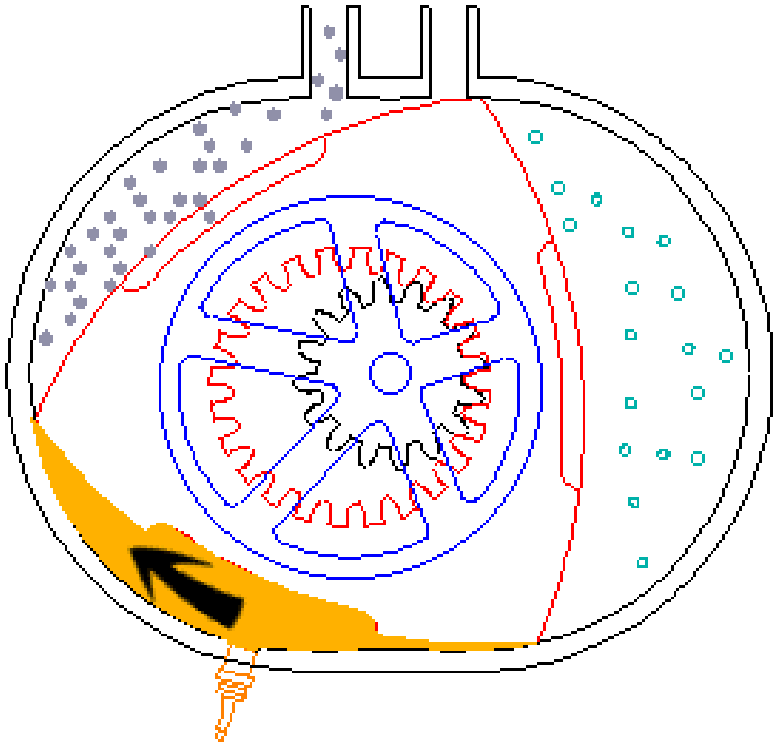
Compression stroke

- The mixture is compressed here.
- Begins after intake
- Volume of chamber decreases
- Fuel/Air mixture compressed
- Chamber compresses to its minimum size



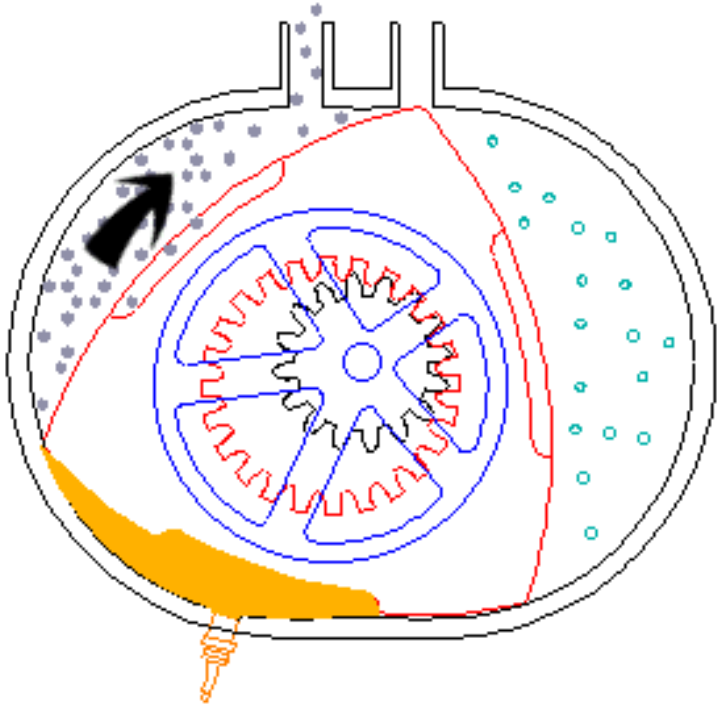
Power stroke

- Spark plug fires and the mixture burns here, driving the rotor around.
- Two spark plugs to maximize amount of fuel ignited
- Causes rapid chamber expansion
- Turns rotor which produces work output on shaft
- Power stroke continues until apex passes exhaust port.



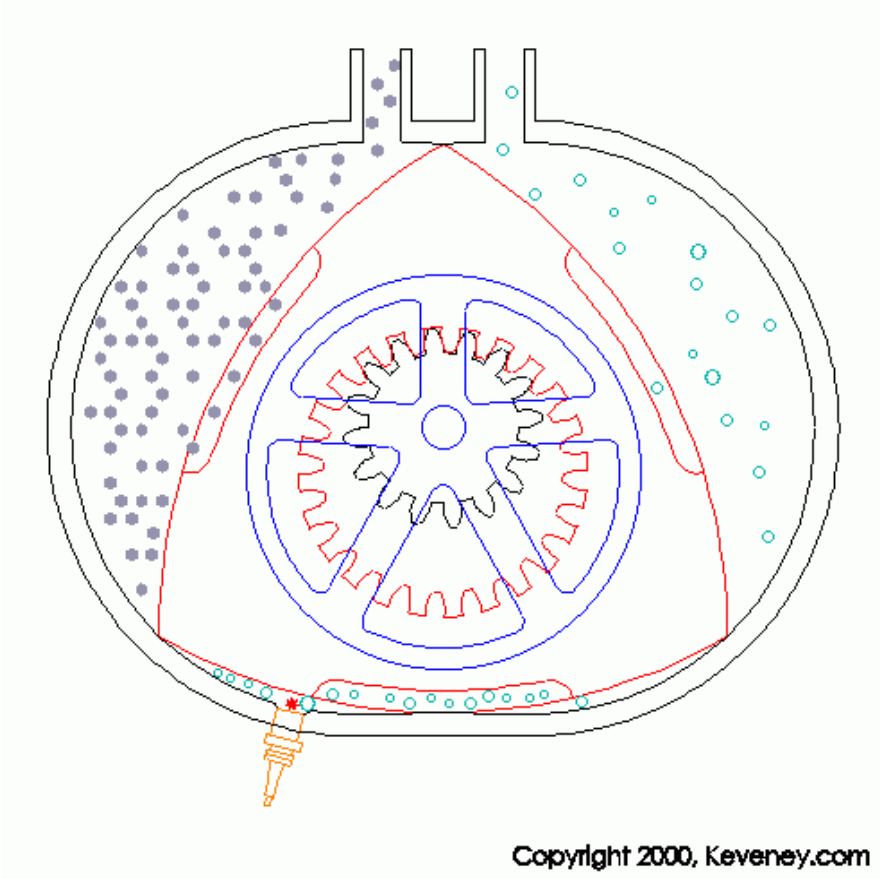
Exhaust stroke

- Chamber decreases in size
- Forces combustion bi-products out the exhaust port
- Continues until next apex passes exhaust port.
- Entire cycle repeats

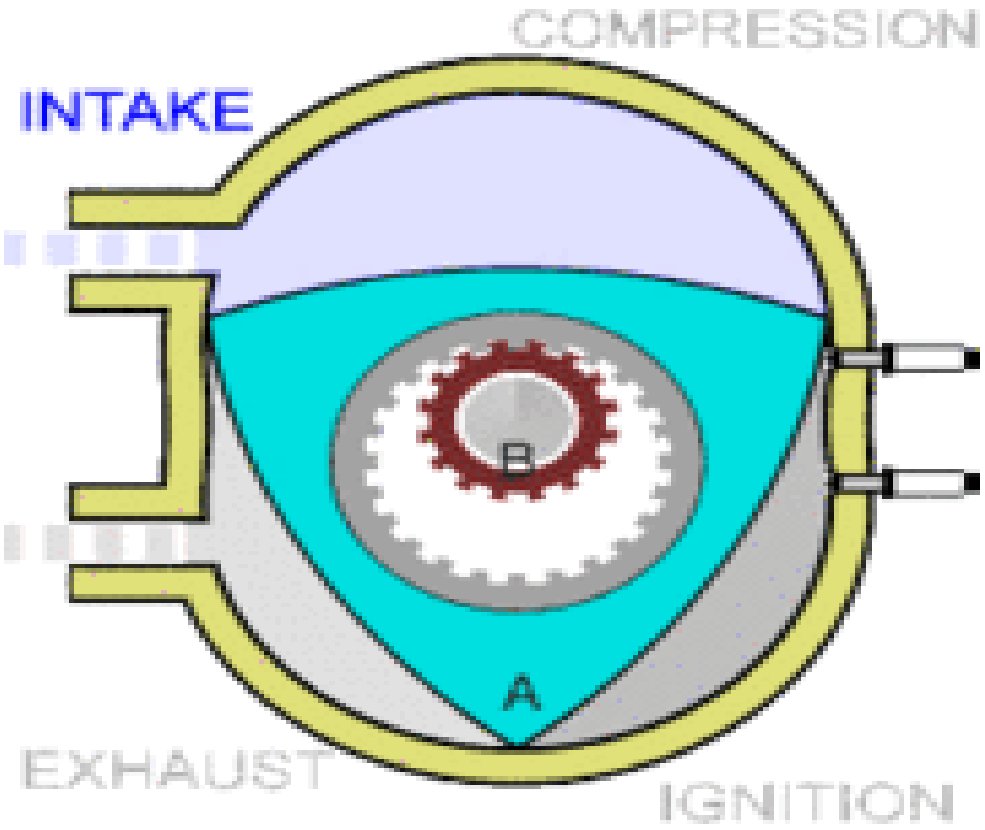


4 - Strokes

All the four strokes – intake, compression, power and exhaust – are going on at the same time around the rotor.



WORKING



- One rotation of rotor provides three rotations of shaft
- Spark plugs fire 3 times per rotor revolution
- One rotation of shaft for each firing of spark plug

Parts

- Rotor
- Rotor Housing
- Side Housing
- Eccentric Shaft
- Stationary Gear

Advantages

- Vibration
  - No unbalanced reciprocating masses
- Power/Weight
  - For similar displacements, rotaries are generally 30% lighter and produce twice as much power
- Simplicity
  - Contain half as many moving parts
  - Have no connecting rods, crankshaft, or valve trains

Disadvantages

- Fuel Efficiency and Emission
  - The shape of the combustion chamber, which is long instead of small and concentrated, makes the combustion travel longer than a piston engine
  - Due to the longer combustion chamber, the amount of unburned fuel is higher which is released into the environment
- Cost
  - The lack of infrastructure and development the rotary engine has caused their production and maintenance costs generally more.

THANK YOU