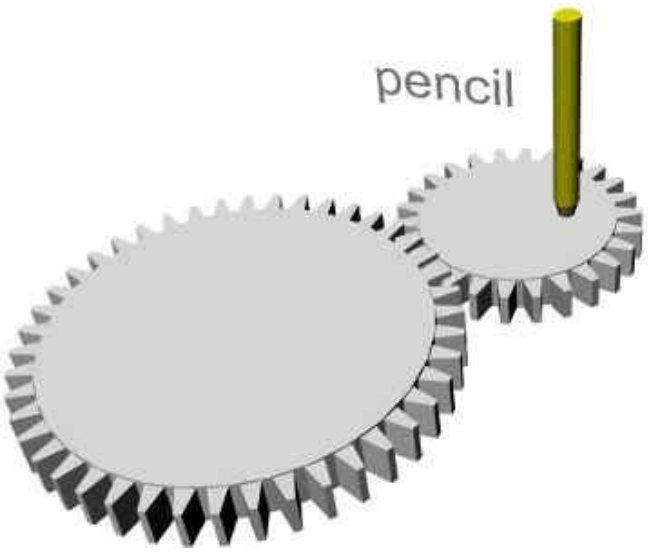
How the Wankel Works Rev. 3 copyright 2007-2010 by Paul Lamar and others.

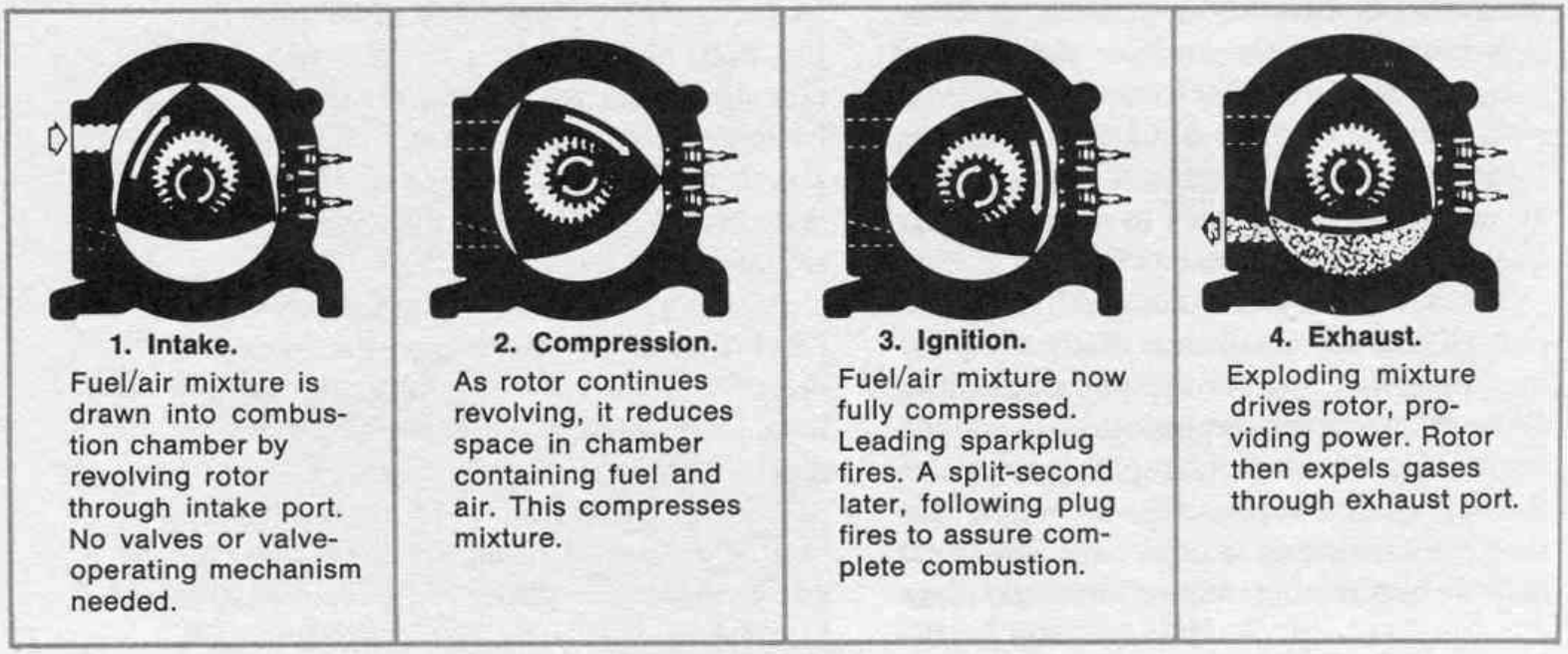
The Wankel rotary consists of a three sided rotor moving in a modified oval chamber or rotor housing. The shape of the chamber is a mathematical construction called an epitrochoid. These curves were studied by Durer (1525), Desargues (1640), Huygens (1679), Leibniz, Newton (1686), L'Hospital (1690), Jakob Bernoulli (1690), la Hire (1694), Johann Bernoulli (1695), Daniel Bernoulli (1725), Euler (1745, 1781). An epitrochoid appears in Durer's work Instruction in Measurement with Compasses and Straight Edge (1525). Nothing new here.



Spirograph is a geometric drawing toy that produces mathematical curves of the variety technically known as hypotrochoids and epitrochoids.

It is also called a Roulette. If you have ever seen a Roulette wheel in motion at a casino you have seen a Wankel engine in motion sort of. To describe the Mazda rotary epictrochoid shaped housings the diameter of the ball is about 1.181 and the diameter of the track (Roulette wheel race) is 9.375 inches. The circuitous path a point on the surface of the ball makes as it rotates defines the epitrochoid shape. This 9.375 inch dimension is also the height of the inside of the Mazda rotor housing. The necked down dimension of the Mazda rotor housing is 9.375 minus twice the ball diameter or about seven inches. The radius of the ball is called the dimension of the Wankel engine. It is also the stroke of the e-shaft so to speak. Think of the rotary as a large bore piston engine with a very short stroke except it does not reciprocate. Of course an apex seal's path MUST match the inner surface epitrochoid curve of the rotor housing as the rotor MUST rotate at one third of the e-centric shaft rotation. Also the radius of the rotor MUST be seven times the dimension. A variation in any of these relationships would cause the engine to jam.

HOW THE ROTARY ENGINE WORKS.



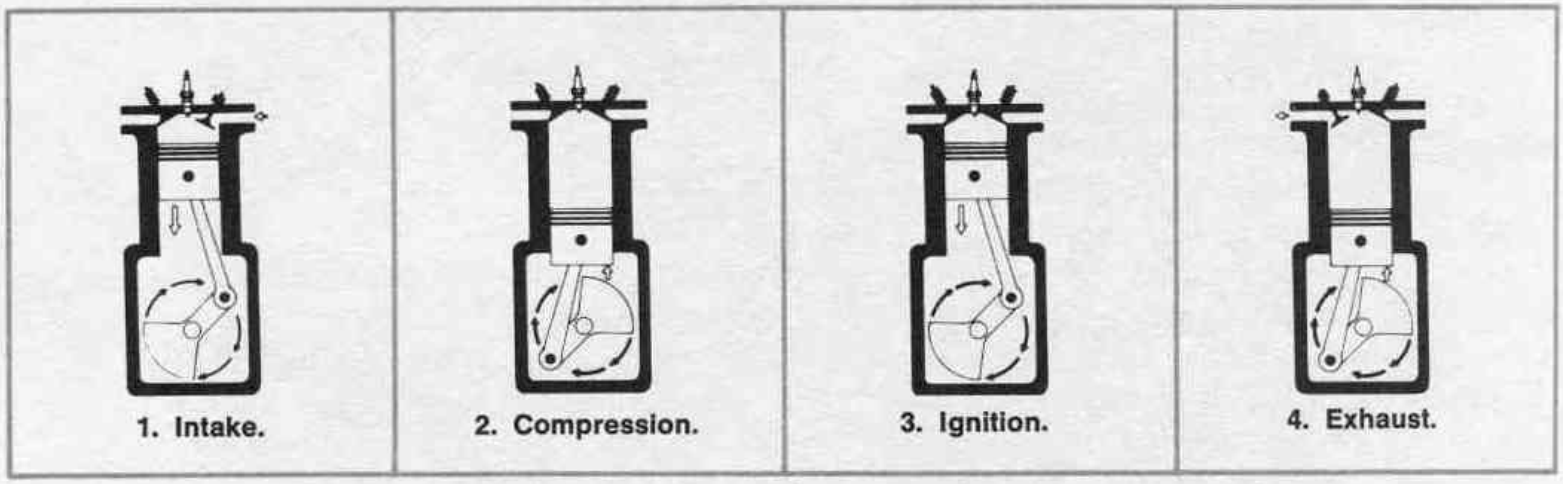
1. Intake. Fuel/air mixture is drawn into combustion chamber by revolving rotor through intake port. No valves or valve-operating mechanism needed.

2. Compression. As rotor continues revolving, it reduces space in chamber containing fuel and air. This compresses mixture.

3. Ignition. Fuel/air mixture now fully compressed. Leading sparkplug fires. A split-second later, following plug fires to assure complete combustion.

4. Exhaust. Exploding mixture drives rotor, providing power. Rotor then expels gases through exhaust port.

HOW YOUR PISTON ENGINE WORKS.



1. Intake.

2. Compression.

3. Ignition.

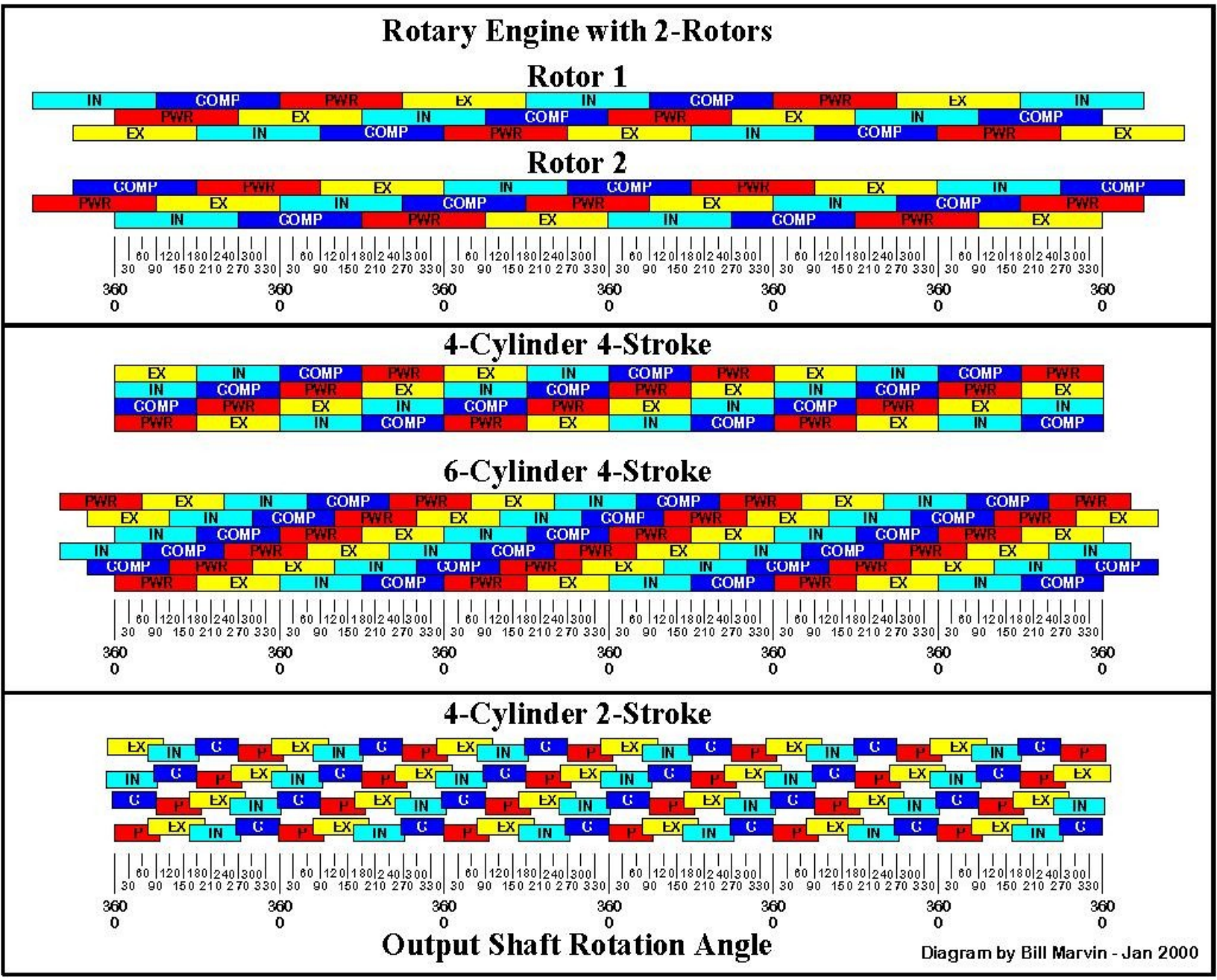
4. Exhaust.

Note: The piston engine must make two revolutions to displace the same amount of air the rotary does in one.

Written by Dave Mix.

The gears inside the rotary are a means of timing the position and orientation of the rotor. This is very much akin to the way timing gears (or chains or cog belts) time the position of the CAMshaft in a piston engine. *** POWER is not transmitted in either case, only the exact POSITION is determined.*** This timing is necessary to put the piston engine valves in the proper place at the proper time. In the rotary this timing is necessary to put the rotor in the proper place and orientation at the proper time.

There are at least two holes in the walls of one side of the rotor housing. In the other side of the rotor housing there is at least one spark plug. One hole is used as an intake port and the other as an exhaust port. Just like a



one cylinder two cycle piston engine. The rotor rotates around the center of the eccentric on the output shaft while at the same time rotating around its own axis. This is very similar to the way the earth rotates around the sun while rotating around its own axis. The engine is sometimes called a planetary engine for this reason. The rotor rotates one third as fast about its own axis as it does around the center of the output shaft. Actually what is happening is the center or CG of the rotor is moving in a circle around the center of the output shaft while the output shaft rotates. Very very clever on the part of Felix Wankel to invent and engine that uses this ingenious motion.

Animation of 2 rotor Wankel engine.

Many engineers and mechanics that should know better still think the rotor translates, reciprocates or wobbles in the rotor housing. Nothing could be further from the truth. The key is to think only of the center of the rotor. That is the center of gravity of the rotor and what that does is all that matters. It rotates around the center of the output shaft in a circle pure and simple. The Wankel is a subtle engine. No doubt about it.

This motion is very important when it comes time to balance the engine. Since there are no reciprocation

parts what so ever it is possible to completely balance the Wankel engine just like a turbine or electric motor and unlike any piston engine despite some claims to the contrary. The rotor is balanced around it own axis. The front rotor balances the rear rotor as they are 180 degrees apart on the output shaft. That leaves a small couple which is finally completely balanced by the counter weights.

As this motion is taking place the tips of the triangular shaped rotor are passing the ports in the housing. As one tip, call it tip 1, passes the intake port in the rotor housing the face behind tip 1 starts to draw in the fuel air mixture. Call it face or chamber A. When the next tip call it tip 2 passes the intake port the mixture is captured and starts to compress in chamber A. As chamber A continues around the housing it encounters the spark plug and the mixture inside it is fully compressed. The spark plug fires and the burning gasses in chamber A start to expand imparting the pressure energy in the burning mixture to the output shaft. As the rotor continues on around tip 1 passes the exhaust port and the burnt mixture starts to leave chamber A.

This completes the four cycles for chamber A. In the mean time chamber B and chamber C are completing various cycles of this same sequence simultaneously. Since the rotor is rotating one third as fast as the output shaft only one firing event and one chamber's volume worth of air is mixed with fuel and processed per revolution of the output shaft. This is the same as a one cylinder two cycle piston engine of the same displacement or a two cylinder four cycle piston engine of twice the displacement.

This three chamber simultaneous action is the reason the Wankel engine is so light and compact for the power it is able to generate. Furthermore the forces in each chamber due to the pressure in each chamber are completely contained in the one piece cast iron rotor. In a four cycle piston engine this is not the case. The compression force must pass down a connecting rod, into the crankshaft and up another connecting rod into another chamber that is expanding and extracting power from the burning mixture. This makes piston engine force paths and consequent stresses far far more complicated and problematic than the Wankel engine. In fact the Mazda Wankel engine is so robust, structurally speaking, it is possible to get as much as 400 HP per rotor. This HP per rotor number is still increasing while auto racers around the world are still developing the engine.

Although the Wankel has similarities with a two cycle engine, particularly in regard with the way the porting mechanism works, it is in no way a two cycle engine. All four cycles are continuously taking place simultaneously and those are intake, compression expansion and exhaust.

Paul Lamar

Here is a very eloquent description of how the Wankel works by Mark LaPierre

What you are seeing is true. Parts of the rotor do experience acceleration and deceleration in relation to the rest of the engine assembly.

The same effect is present inside the rotary engine. The rotor is spinning about it's center of gravity, just like the tire on the car, while at the same time it is orbiting around the center of the E shaft. There is no vibration imparted to the E shaft, same as there is no vibration imparted to the axle shaft as the car goes down the road. The forces within the rotor are in symmetry.

There is a force applied to the E shaft. It is the centrifugal force generated by the mass of the rotor orbiting around the E shaft. The rotation of the rotor about it's own center of gravity has no effect on the E shaft. As far as the E shaft is concerned the rotor could be fixed to the E shaft and rotating with it. Of course that wouldn't make for a very inefficient engine as the rotor would just be describing a circle. Consider the rotor as being round just like the tire. The E shaft doesn't know that the rotor is a triangle. It just feels the unchanging mass of the rotor pulling on the shaft.

The force applied to the E shaft is always directed through the eccentric from the low side toward the high

side. In a single rotor engine that force is balanced by placing counter weights on the E shaft in front and behind the rotor in such a way as to avoid creating a couple. In a two rotor engine the rotors are 180 out of phase. The result is a couple were the forward rotor would be pushing the front of the engine assembly up while the rear rotor would be pushing the rear of the engine assembly down. This couple will rotate with the E shaft, not the rotors. It is balanced again by placing counter weights on the E shaft front and rear.

Again, like the tire, parts of the rotor experience acceleration and deceleration relative to the rest of the engine assembly but do not experience any acceleration/deceleration in relation to the rest of the rotor. The rotor is just spinning around it's center of gravity just like the tire. It's tough to get your head around.

Mark LaPierre