ROTARY COMBUSTION ENGINE

This article is about internal combustion engines that do not use conventional pistons. See also rotary engine for the World War I aircraft engines by that name.

A rotary engine is an internal combustion engine that does not use pistons in the way a reciprocating enginedoes, but instead uses one or more rotors, sometimes called rotary pistons.

Further clarification

The term rotary combustion engine has been suggested as an alternative name for these engines to distinguish them from the obsolete aircraft engines also known as rotary engines. However both continue to be called rotary engines and only the context determines which type is meant. In particular, the only commercial producer of (pistonless) rotary engines as of 2005, Mazda, consistently refers to their Wankel engines asrotary engines.

The basic concept of a (pistonless) rotary engine is to avoid the reciprocating motion of the piston with its inherent vibration and rotational-speed-related mechanical stress. As of 2005 the Wankel engine is the only successful pistonless rotary engine, but many similar concepts have been proposed and are under various stages of development. There are countless other examples of rotary engines varying in rotor design, size and many other categories. Notable examples include:

- The quasiturbine.
- The Sarich orbital engine.

- A rotary engine developed by Texas machinist Frank Turner which was licensed by Malcolm Bricklin for use in place of the V8 powering the Bricklin SV-1 vehicle, but never used.
- The Rand Cam engine

Advantages

All such engines have the potential to improve on the piston engine in the areas of:

- Higher power-to-weight ratios.
- Mechanical simplicity.
- Less vibration.

While typically larger than the piston of an engine of corresponding capacity, a rotor may perform manystrokes per revolution. The Wankel produces twelve strokes per revolution of the rotor (four strokes per chamber times three chambers) (although the spindle rotates three times faster than the rotor or three times over the twelve strokes), as opposed to two strokes for each crankshaft rotation of a single-cylinder single acting piston engine, or four strokes for a double-acting cylinder such as found in some steam engines. The quasiturbine delivers sixteen strokes for every rotor (and spindle) revolution.

Disadvantages

In practice, the main problem of the Wankel engine has proven to be the seals, and as of 2005 all proposed designs have some of the same potential weaknesses.

Although in two dimensions the seal system of a Wankel looks to be even simpler than that of a corresponding multi-cylinder piston engine, in three dimensions the reverse is the case. As well as the rotor apex seals evident in the conceptual diagram, the rotor must also seal against the chamber ends. Worse still, these two sets of seals must somehow join at sharp corners at the ends of the apex seals.

An additional problem is that the seals at the Wankel rotor apexes meet the chamber walls at an angle that varies plus and minus ~26 deg; during the cycle, while a piston ring meets the cylinder walls at a constant angle. As well as making the seal design itself more difficult, this means that while multiple rings are easily fitted to a piston, a corresponding approach is impossible with the Wankel apex seals. This limitation is addressed in the Quasiturbine AC design, but the simpler Quasiturbine SC design has the same problem of varying seal angle as the Wankel.

Piston rings are not perfect seals. Each has a gap in fact to allow for expansion. Moreover the sealing at the Wankel apexes is less critical, as leakage is between adjacent chambers on adjacent strokes of the cycle, rather than to the crankcase. However, the less effective sealing of the Wankel is one factor reducing its efficiency, and confining its success mainly to applications such as racing engines and seat belt pretensioners where neither efficiency nor long engine life are major considerations.

Another disadvantage of the Wankel engine in particular is the large surface area of the combustion chamber which reperesents a large heat transfer and quench area, combined with an unfavorably long rather thin stretched combustion space necessitating long flame travel. The combustion is less complete than in e.g. an RPE having a more compact chamber shape with smaller area per chamber volume.

Comparisons

The simplest design, either proposed or in use, is the Wankel. Its only moving parts are a three-sided rotor turning on a straight spindle; There is neither crankshaft nor camshaft. The rotor is not fixed to the spindle, but turns it by means of an internal gear on the inside of the rotor engaging a smaller conventional gear on the spindle. The rotor is positively located by the spindle and the geometry of the rotor and engine chamber. There is still some vibration, as while the centre of gravity of the spindle does not move, that of the rotor does. The angular momentum and kinetic energy of motion of the rotor also both vary, producing more vibration, seeengine balance. A Wankel engine fires three times for every revolution of the rotor, so a single rotor is in some ways equivalent to a six-cylinder reciprocating engine.

However since the output shaft turns faster than the rotor (the ratio is 3:1) effectively at the output shaft there is one "power" stroke per revolution, hence a single rotor-casing combination is the equivalent of a two-cylinder four-stroke (Otto cycle) engine (reciprocating engine).

A two-rotor design has been adopted by Mazda to further reduce vibration, and three- and four-rotor designs have been used in racing, notably the 4-rotor Mazda 26B engine that powered the winning car in the 1991 24 Hours of Le Mans race.

There are various methods of calculating the engine displacement of a Wankel; the Japanese regulations calculating displacements for engine ratings calculate on the basis of the volume displacement of one rotor flank only.

In the most popular Mazda family of engines, the 13B, this consists of two rotors displacing approximately 650 cc (cubic centimeters) each per rotor flank, a total of approximately 1300 cc or 1.3 l (liters). As clarified about in terms of reciprocating engines, this is the equivalent of 2.6 l displacement.

The Sarich orbital engine has a larger number of moving parts than the Wankel. The six-chamber design used for the prototype has, conceptually, eight moving parts within the engine chamber as opposed to two for the Wankel. However it also requires six spark plugs, one per combustion chamber, as opposed to one per rotor for the Wankel (although two are commonly used in practice for performance reasons). The Sarich was developed to the point of being demonstrated running briefly as a bench-test with no load before the design was abandoned.

The Quasiturbine AC design is more complex still than the Sarich. Even with only two wheels per carriage, there are at least nineteen moving parts within the engine chamber including the shaft and differential, and possibly more depending on the design of the differential. In common with the Wankel, the Quasiturbine only requires a single spark plug. A prototype of the Quasiturbine AC design was constructed and turned by an external engine for 40 hours, but ignition was never achieved.

The Quasiturbine SC design is greatly simplified from the AC, but still has at least seven moving parts within the chamber, including the shaft and again possibly more depending on the design of the differential. The SC design has been demonstrated as a steam and pneumatic engine, but as of 2005 not as an internal combustion engine. Prototype steam engines have run for periods of up to a few hours.

Source : http://engineering.wikia.com/wiki/Rotary_combustion_engine