INDUSTRY

Renesis: A Closer Look

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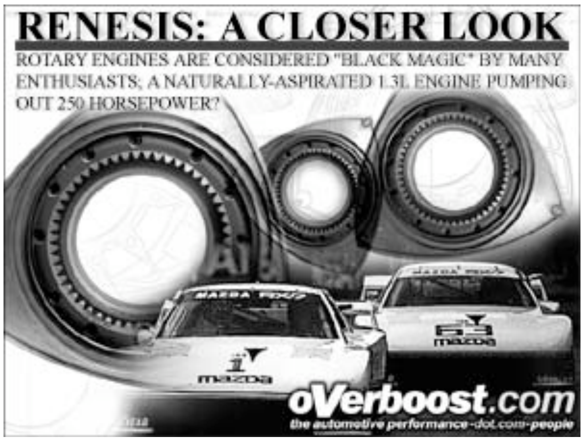


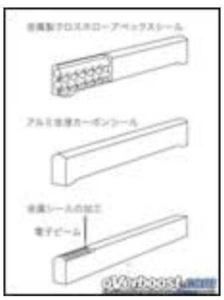
We've been to dozens of car shows. You see the hood of a Civic propped open and other Honda enthusiasts swarm. "What kind of pistons do you use?" "What intake manifold is that?" Check out a Mazda RX-7 with the hood open, and people are quiet. They're staring in awe, sure, but they're also not quite sure what to make of that stumpy thing that the turbocharger is bolted to—it sure doesn't *look* like any internal-combustion engine!

It's hard to say why an engine with only 11 primary parts intimidates the average wrench, but perhaps exploded views and cutaways will put everything into perspective. The left photo indicates the major assemblies of a Renesis engine. At the top are the five pieces us "reciprocating guys" would consider the cylinder block. On the far left is the rear portion of the block that bolts to the transmission; on the far right is the front of the block, which ends up near the radiator when installed in a vehicle. The two silver portions of the housing contain the peanut-shaped combustion chamber where the rotary magic monkey-motion takes place, the trochoid, and the center piece separates the two rotor combustion chambers. (The center photo is a side view of the chamber with the triangular rotor within.) In the middle row, left to right are the intake manifold, throttle body, rear "stationary gear," the two rotors and the front stationary gear. Just beneath the rotors is the rotary equivalent of the crankshaft, which we'll go ahead and call the eccentric shaft since we're all becoming rotary converts. Across the bottom, left to right, are the rest of the intake manifold and the exhaust manifold. The photo on the right gives a good overview of how the two pieces of the intake manifold relate to one another and the rest of the air intake tract.

Let's take a step back and briefly discuss the stationary gear. In the center photo you can see how the stationary gear is nestled into the center of the rotor; the gear itself is solidly bolted to the engine block, and its job is to ensure that combustion pressure is able to *spin* through its combustion cycle. Without it, the eccentric shaft could turn, but the rotor would just flop up and down in the chamber.

Before we get too far ahead of ourselves, no rotary engine discussion would be complete without a little history lesson. You may have heard rotary engines being referred to as Wankel engines; this would be because Dr. Felix Wankel invented it. Although originally thought to have been conceived in the late 16th century, unofficial history has it that Dr. Wankel literally dreamed about a working rotary engine at the age of 17 (the year was 1919) and had a working prototype by 1957. Of course, as with most things of the era, ideas moved faster than technology and science simply hadn't yet made available materials with the mechanical properties to mass-produce the rotary while keeping costs in a reasonable range. The center photo shows a 400cc prototype rotary, an early evolutionary Neanderthal model of the rotary. The photo on the right shows internal damage to the trochoid caused by the seals on the apex of the rotors chattering (galling/seizing) against the friction surfaces. Additionally, early rotaries smoked like locomotives because of excessive oil consumption. Even though seemingly plagued with problems, the fundamental theory behind the rotary was so sound that 100 companies around the world attempted to get their hand into the rotary bag.



Fortunately, the Japanese made a breakthrough that drastically reduced the tendency of apex seals to chatter and gall against the trochoid housing. It was determined that the seals vibrated at their natural frequency in certain RPM ranges, so the Nippon Piston Ring Company altered the natural frequency of the seals by drilling two holes lengthwise in the seals to lighten them, in turn raising their natural frequency to a range where they'd only judder in an RPM range well out of reach of an internal combustion engine. Following the evolutionary path of the engine as a whole, the seals also changed and are now made from either molybdenum-coated iron or an aluminum/carbon composite.

Once problems with the seals were ironed out, single-rotor test engines were built and used in some forms of motor sports. Although they worked better than single-piston engines, it was discovered that single-rotor engines didn't work well when heavily loaded. (They had about the same torque flux as a three-piston engine, which is to say, not real nice.) Necessity is the mother of invention, so engineers took advantage of the modular nature of the rotary engine and simply added another rotor, giving the engine the feel and torque characteristics closer to that of a six-cylinder engine. The two-rotor design stayed in place and is what made it to production vehicles. Mazda has also created several three-rotor engines, which have a torque flux similar to an eight-cylinder piston engine; these are normally reserved for Mazda's ultrahigh performance road cars and racecars.

In May of 1967, the first two-rotor production vehicle hit the streets of Japan, the Cosmo 110S. It made somewhat of a sensation in motoring circles because cars of the day simply couldn't cram a piston engine underneath a low-slung hood. People knew this car wasn't a toy—it did the quarter mile in 15.8 seconds!

Mazda demonstrated the flexibility of their rotary engine by using it in applications where one would not expect to see a dinky 1.3-liter engine; the Parkway Rotary bus was one of them. Packing 135 horsepower, we wouldn't expect this thing to be a rubber burner (indeed, the air conditioning compressor had to be driven by a separate engine), but the bus did weigh in at 6,360 pounds dry and the 1.3L was able to motorvate this plus 26 passengers. Imagine seeing a *bus* with that rat-rat-rat exhaust note!

In another demonstration of the rotary's flexibility, Mazda designed the HR-X2 concept car, which used a hydrogen-powered variant of the 13B.

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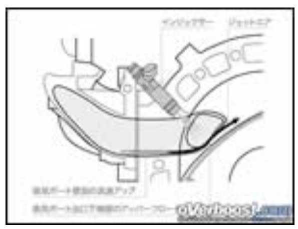
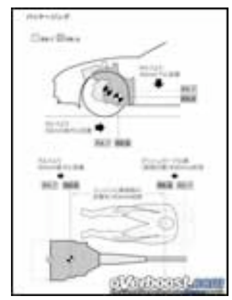
North America has enjoyed two major rotary players, the rotary pickup and the RX-7. (The pickup was available from 1973 to 1977, while the RX-7 was available from 1978 to 1996.) The 1.3-liter 13B series engines used in the '78 to '96 RX-7s didn't change much from year to year; while the induction and exhaust schemes changed dramatically, the fundamental design of the rotary didn't change much at all, retaining the design flaws year after year. With the intake and exhaust ports located in the rotor periphery, which caused a slight timing problem between intake and exhaust events, causing unburned gasoline to be dumped into the exhaust. Increasingly strict tailpipe emissions laws in the US eventually caused the rotary to go obsolete.

When consumer demand indicated reintroduction of a rotary-powered sports car, Mazda was forced to further refine the rotary engine to make it suitable for use in the 21st century. A main design change was made to the trochoid housings, removing the intake and exhaust ports from the periphery and putting them into the side housings. This change eliminated the intake/exhaust timing issue and really cleaned up the exhaust emissions of the rotary. Additionally, since there are two sides to both rotors, Mazda engineers were able to squeeze in an additional exhaust port for each rotor; one per side. In the end, both intake and exhaust ports have approximately 30% more breathing area than the 13B rotaries. Mazda engineers also incorporated a dual-length intake manifold into the new rotary for a flatter torque curve—yes, flatter than even the older rotaries. (Left photo, peripheral port rotary. Right photo, side port rotary.)





As used in Mazda's new RX-8 sports car, the 13B was reborn and renamed: Renesis. Renesis is a shortening of the term "RE Genesis," with RE standing for Rotary Engine. Since there are only a select few people on this earth that enjoy the earsplitting tone of a 13B exhaust note, Mazda engineers actually went through a great amount of trouble to deepen and "refine" the exhaust note. (Dare we say they made it sound more like—gulp—a piston engine? –OVB) Since it's tough to make 250 horses with one huge fuel injector per rotor, Mazda uses three smaller injectors per rotor. A small tube within the intake manifold provides a small, high-speed air curtain, which enhances fuel atomization. Without the turbocharger gear of the FD3S RX-7, the overall dimensions of the Renesis are kept minimal, allowing the engine to sit lower and further back in the chassis for more advantageous weight distribution.

In 1997 we asked if the rotary would ride again. Our prayers have been answered like a phoenix rising from its ashes.