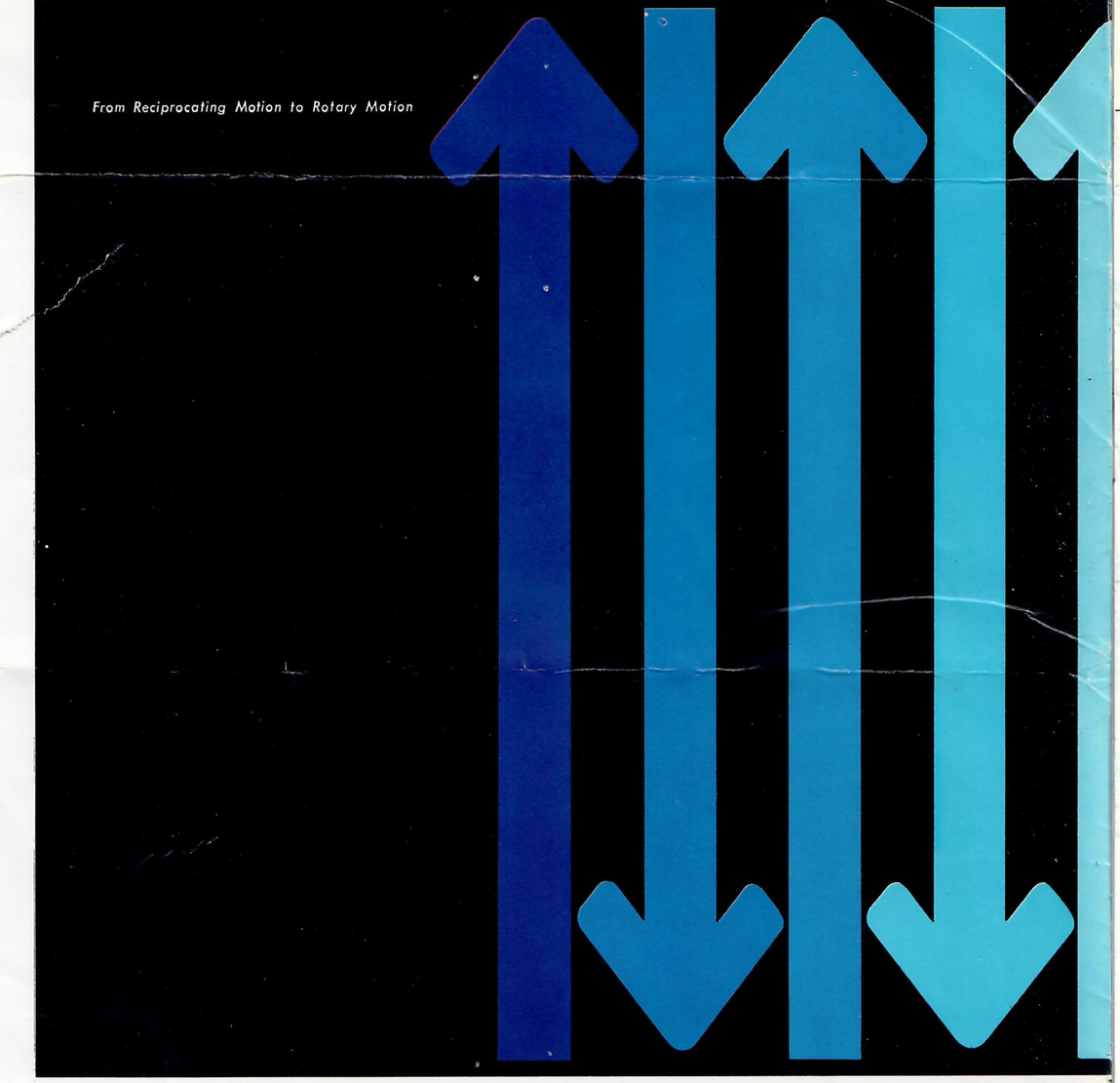
MAZDA ROTARY ENGINE

From Reciprocating Motion to Rotary Motion

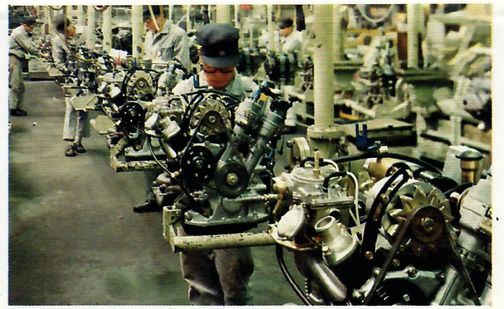


First volume producer of rotary engine cars–already over 120,000 units in sixty countries.

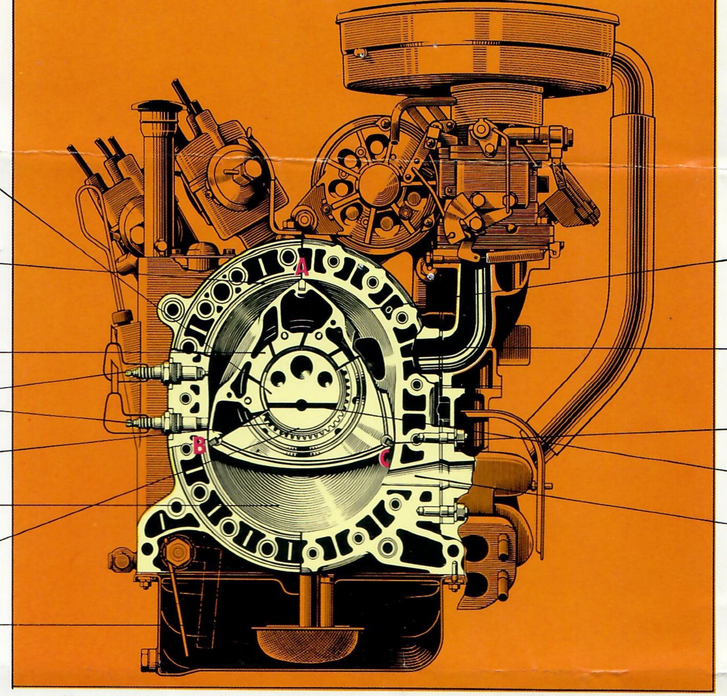
General Motors is spending US$50 million to develop a rotary engine—Mazda now supplies rotary engine automobiles.

Expressway networks extend over many countries of the world. The automobile is a necessity and today, many people measure distance by driving time rather than by kilometers or miles. Cars, therefore, should have sensitive acceleration and high-speed performance and, most importantly today, should add as little as possible to environmental pollution. Thus it is essential that a high performance automobile engine be developed with non-polluting exhaust characteristics. This situation has focused the world's attention on the rotary engine car as the "new" automotive power plant. GM has recently commited US$ 50 million for the license of the rotary engine; Benz, Alfa Romeo, Porsche, and Nissan have also recently started research and development of the rotary engine. However, Mazda, the world's formost authority on rotary engine mass-production techniques already have in excess of 120,000 rotary engine cars in action around the world. In May 1967, we produced our first rotary engine car, the Mazda 110S; now we produce 10,000 per month. The rotary engine has been accepted throughout the world with a readiness never before experienced in engine development.

MAZDA ROTARY ENGINE: LICENSE NSU-WANKEL



Rotary Engine Production Lines



Dream Engine Realized

In traditional reciprocating engines, the pistons' up-stop-down-stop movement is created by exploded energy thus producing power. However, this vertical piston motion can not turn the wheels of a car. It must first be changed into rotary motion by means of an elaborate crankshaft. Crankshaft motion has long been considered inefficient and to eliminate it many efforts have been made to develop a more rational engine. The idea of a rotating piston dates back about 400 years. James Watt, inventor of the steam engine, tried to develop the idea but was unsucessful due to his inability to solve problems of durability, sealing, etc. The rotary engine theory was an idealistic, but seemingly unworkable, engineering proposition.

Advent of the Wankel Rotary Engine

Dr. Felix Wankel

Dr. Felix Wankel, born in 1902 in Southern Germany, again conducted systematic research into the rotary engine. In 1951 he succeeded in solving various problems using his rational ideas. He developed a triangular rotor with an epitrochoidal chamber.

When the rotor revolves in the figure 8-shaped chamber, its apexes are in constant sliding contact with the wall inside the chamber. Thus, the apexes of the rotor form large and small spaces successively, in principle, simulating the role of the conventional reciprocating piston. Dr. Wankel had made the first breakthrough.

In 1967, Toyo Kogyo succeeds in producing a practical rotary engine

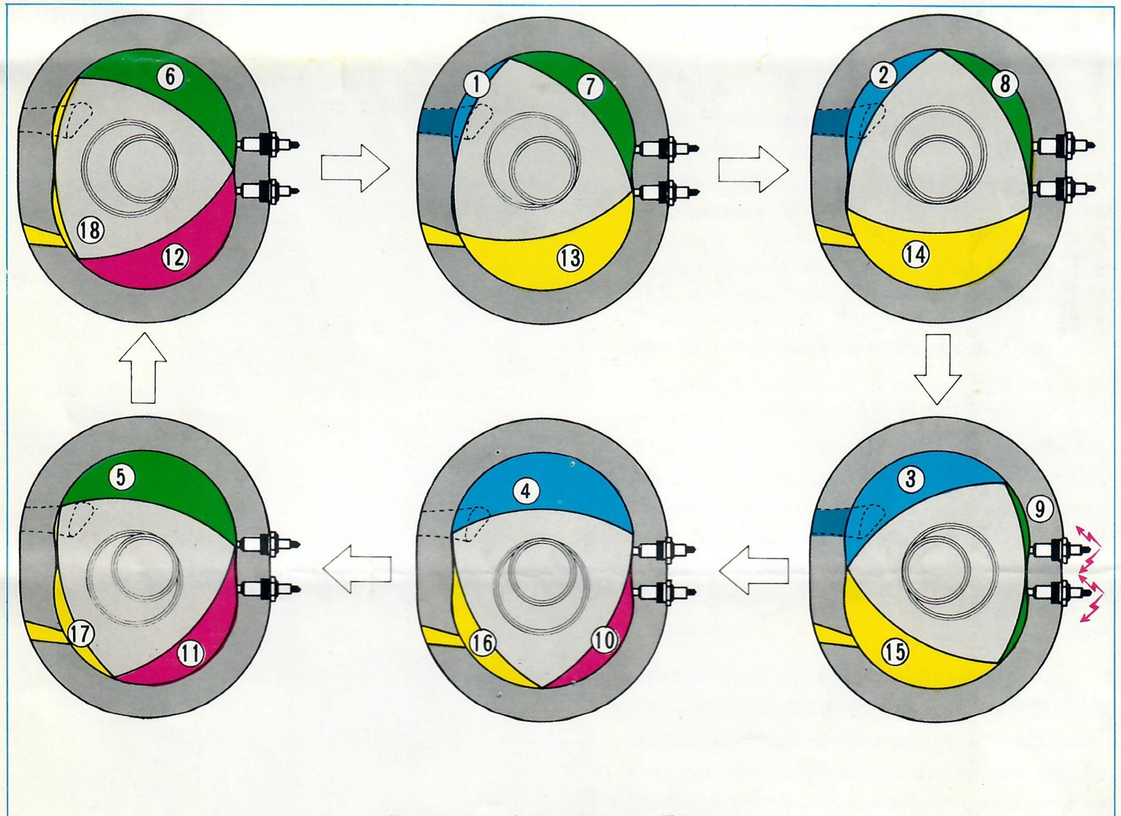
In 1959, Dr. Wankel and NSU announced the results of durability tests on his rotary engine designated "KKM250". But there still remained problems in manufacturing, sealing complexities, mass production, etc. Anticipating a bright future for the rotary engine, in 1961 we conducted a licence agreement with NSU/Wankel of West Germany. We developed the Wankel engine into a multi-rotor powerplant, thus assuming a leading role in the development of the rotary engine. We further improved carbon and oil seals to make them more durable and re-designed the intake port to produce more complete combustion and better low speed performance. By solving the problems one by one, in 1967 we developed a rotary engine much-modified from the Wankel design, and we put it in a car, the Mazda 110S.

Direct from Combustion to Rotary Power

See the diagrams. The revolving rotor inside the figure 8-shaped chamber (rotor housing) draws the fuel into 1, 2, 3 and 4. When the chamber space between the housing and the rotor is at its largest, the rotor compresses the fuel into 5, 6, 7, 8 and 9. At 9 the spark plug fires and causes combustion. Then the fuel is expanded in 9, 10, 11 and 12. And at 13 the exhaust fumes are released through the exhaust port.

All three sides of the rotary engine's rotor operate simultaneously so that one revolution of the rotor causes three combustions, each one producing power. This means that a 2-rotor rotary engine's combustion strokes correspond (per crankshaft revolution) to those of a six-cylinder reciprocating engine.

Moreover, the rotor's revolutions are transmitted directly to the output shaft. Therefore, it does not require a system to transform reciprocating motion into rotary motion as in the case of reciprocating engine.



Principle of the Rotary Engine

1—4 ..... Intake
5—9 ..... Compression

The Rotary Engine Opens a New Automotive Chapter

(1) Smooth Acceleration and Gear Flexibility

The operating part of the rotary engine transfers the rotor's motion directly to the wheels, thus making high speed rotation possible. This was difficult with the reciprocating piston engine due to inertia. The intake and exhaust systems are designed to idle smoothly and to respond instantly to any rotary motion. This response is available at any speed from low to high. The flat engine torque effortlessly increases r.p.m., and gives amazing high-speed acceleration for expressway passing. The rotary engine is ideal for high-performance automobile use.

(2) Quiet-running, Vibration-free Engine

In reciprocating piston engines, the rectilinear and rotary motion of the connecting rod and the up and down motion of the piston causes inertia. Unavoidably therefore, the engine itself vibrates in all directions. Also, this type of engine's valves and other complicated parts of the intake and exhaust systems are quite noisy which makes quiet, high-speed performance impossible. The rotary engine has no parts that cause inertia and mechanical noise. The unique operating principle of the 2-rotary engine in Mazda cars equals the smoothness and performance of a six-cylinder piston engine.

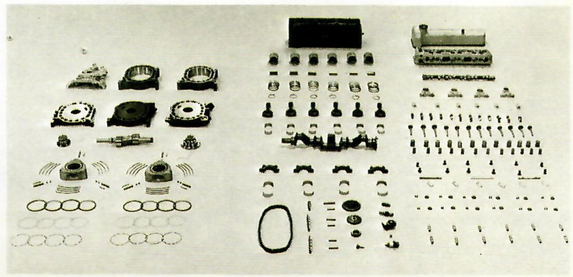
(3) Lightweight and Compact

The rotary engine's external size, is about 50 per cent smaller than that of comparably powerful reciprocating piston engines. It also weighs about half as much. This low weight/high performance ratio becomes very advantageous in larger engines and brings about many new possibilities in the layout of cars.

(4) Fewer Parts and Simple Construction

The rotary engine is inherently simple in construction and has fewer parts than the reciprocating piston engine. Therefore, there is less chance of trouble. And should anything go wrong, it can easily be repaired. Its production efficiency can be greatly streamlined making it ideal for mass production. Thus, the rotary engine has many producer/user advantages.

Mazda rotary engine cars, RX-2 Coupe & R100 Coupe (U.S.A. Model)

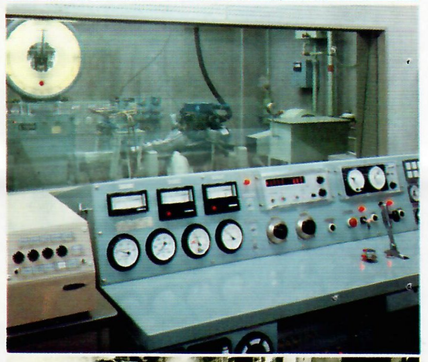


Parts Comparison between RX-2 Rotary Engine and 6 Cylinder 2.7 L Reciprocating Engine

The Rotary Engine is the First Choice for a Car that Causes No Environmental Pollution

The United States Congress recently passed the Muskie Bill underscoring the fact that environmental pollution is now a worldwide social problem. Thus attitudes towards automobiles are changing. Cars should no longer be considered more vehicles, but must be quiet, safe and emit exhaust fumes which do not pollute the air. The Mazda rotary engine meets all these requirements. It is quiet running, gives top-level performance and is easily modifiable not to pollute. The rotary engine is ideal for all cars, and the general worldwide trend reflects this not-too-distant possibility.

The Mazda rotary engine control room at Toyo Kogyo



Exhaust emission inspection of the United States Government

High Performance from No-Lead, Low-Octane Gasoline

Another worldwide social problem is lead pollution in city centers. This kind of pollution is caused by the lead compound which is added to gasoline to increase its octane rating. A non-leaded gasoline is planned to cope with this problem. This, of course, will reduce the performance of reciprocating piston engine, high-octane cars. The rotary engine has a different combustion system which gives high performance even on no-lead, low octane gasoline. It is unnecessary to replace or improve any of the parts.

The Rotary Engine's Combustion System Produces Less Oxides of Nitrogen (dangerous to respiratory organs, causes smog)

Exhaust fumes contain carbon monoxide and hydrocarbons, which are dangerous to the human body. They can, however, be eliminated by simple processes (thermal reactor, catalyzer). Nitrogen oxide which causes city smog is difficult to eliminate. The rotary engine has a unique combustion system with a movable combustion chamber which causes the least amount of nitrogen oxide—an inherent anti-pollution characteristic.

Development of Exhaust Reactors

The rotary engine greatly reduces the emission of oxides of nitrogen in the process of combustion—something hitherto considered difficult to accomplish. Mazda has already developed a thermal reactor which oxidizes carbon monoxide and hydrocarbons. Some rotary cars (those exported to U.S.) are equipped with this thermal reactor and emit innoxious carbon dioxide and vapor. The size advantage of the rotary engine makes practical the attachment of such equipment.

MAZDA

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