Shaping an Improved Diesel

It sounds like America's dream car, but can they make it?

BY JANET RALOFF

An automotive diesel that can match the performance and weight of conventional (spark ignition) gasoline engines with a potential increase of 20 to 25 percent in the number of miles per gallon that it can deliver, is under design at the University of Rhode Island. URI's George A. Brown, a mechanical-engineering professor and one of the engine's designers, calls it a triangular, quadratic expander — TQE for short. "It will go faster, smoother and be smaller than any compact car engine on the market now," Brown says.

A two-chamber engine producing 50 horsepower — similar to what is used in some Volkswagens — would be 30 percent smaller than those now used in compact cars, he says. "The space savings can be converted into more passenger or cargo room, or the car can be manufactured just that much smaller," he says. And the noise should be significantly lower than that of conventional diesel engines. But the TQE diesel resembles a conventional diesel about as much as a rotary Wankel resembles a piston.

In the TQE diesel, three identical, overlapping triangular elements, which Brown calls hedrons, serve the function of a piston. The hedrons move like the iris of a camera lens, dilating or contracting to vary the volume of the ignition chamber, which their displacement forms. As the hedrons move toward a maximum-volume position, air entering a pumping chamber is compressed. Near the hedrons' maximum-volume position, air-transfer passages are uncovered, permitting air to enter the ignition chamber and to wash out spent gases through exhaust ports. As the hedrons return to their minimum-volume position, air in the ignition chamber is compressed, drawing a fresh supply of air into the air-pumping chambers. Fuel injection and ignition occur near the minimum-volume position.

The primary advantage of the TQE over a piston is that as hedrons move laterally along their respective baselines at a *constant* (or linear) rate, the ignition-chamber volume varies at a *geometric* rate — in this case, as the square of hedron motion. This nonlinear expansion of the ignition chamber increases the residence time of gases in it prior to fuel injection. Longer residence times mean the air in the chamber is hotter when the fuel enters. And this is important in any diesel because it's the heat of the air in the ignition chamber that ignites the fuel.

In a spark-ignition engine, air and gas mix in the carburetor before entering the engine cylinders as a vapor. When the spark plug sparks, combustion occurs. But in a diesel, hot, compressed air enters the ignition chamber alone; the fuel is injected later, after the air has been compressed much further.

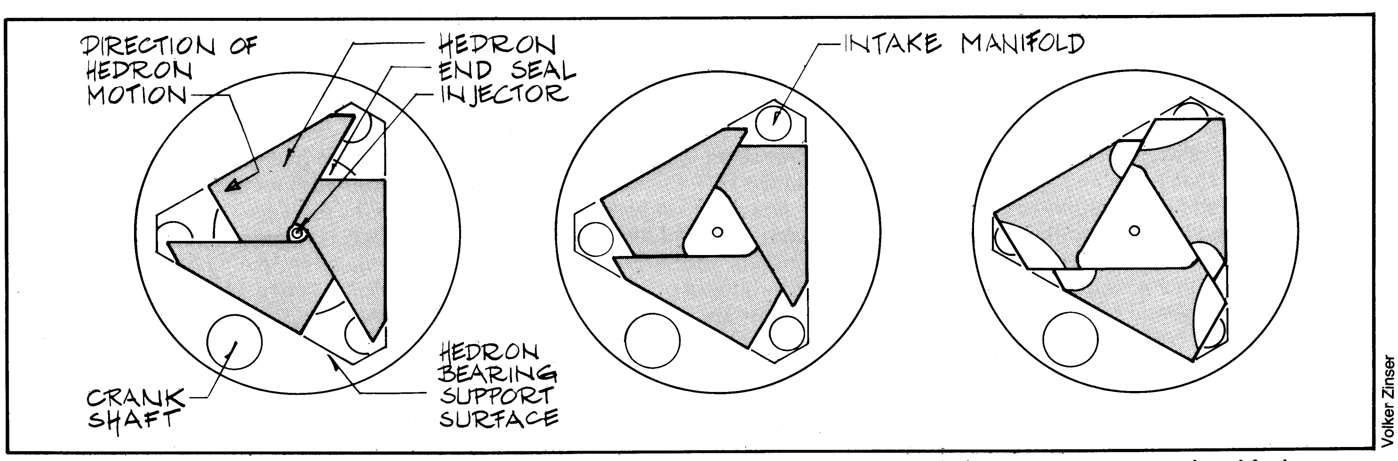
The time it takes for the hot air to warm, vaporize and ignite the fuel is called ignition delay, Brown explains, and accounts for why the diesel is a slower engine — running as much as 1,500 revolutions per minute slower than a comparably powered spark-ignition engine. A slow engine means slow acceleration, he says, a characteristic drivers don't appreciate.

High compression ratios (the degree to which ignition chamber air is compressed) account for another unpopular diesel trait — weight. Compression ratios may be two to three times higher in diesels than in spark-ignition engines; they have to be to heat chamber gases to temperatures that will ignite fuel. But added compression means that in ordinary diesels, engine parts must be made heavier and stronger to withstand the high internal pression means that in ordinary diesels engine parts must be made heavier and power than small ones to propel their added weight.

So why drive a diesel? Fuel economy. Diesels are more efficient, thermodynamically. They also run on a wider range and on a generally cheaper grade of fuel.

Norm Buske, a young inventor, is responsible for the TQE concept. He convinced URI to aid in design and construction of a prototype engine in return for 15 percent of any money the patent may earn. But right now Brown is not too concerned with when or whether that may occur. "As a teaching tool, all students benefit from work on the hedron engine," he says. In fact, it was two students working on the TQE as part of a design course who seem to have solved what had been a major design challenge — sealing the ignition chamber. If their concept works, they will share in URI's 15 percent.

Parts for the first engine will be machined this year. If all goes well, there should be a working model next year. But that's not the end of it. Brown is now focusing on combustion characteristics, such as how the fuel and air will swirl and ultimately burn within the combustion chamber. The geometry and potential are so good, he says, but the combustion dynamics so uncalculable. And they "can make or break the system." All you can do, he says, is test the system, watch what happens, and return to the drawing board. □



Dilation of TQE chamber from minimum-volume position (left) to maximum volume (right). Air is most compressed and fuel enters at minimum-volume position. Expansion of combustion gases in burning forces the hedrons apart, rotating the chamber and crankshaft to move the car. Since chamber is not empty at minimum volume, hedrons would probably never close entirely to "zero volume."