



# Inventing The Piano And The Music To Go With It

STREETSMARTS IS CONDUCTED BY STEVE STURGESS

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**T**hink you can have an internal combustion engine without a mechanically driven camshaft to time the management of air and fuel? Sure you can. Sturman Industries and International Engine proved you could and together drove coast to coast with a medium-duty International diesel truck a decade ago to show it could be done.

Think you can have an internal combustion engine and eliminate both camshaft and crankshaft? You know where this is going ...

Sturman's latest concept, of course, does just that. Instead of turning the chemical energy in the fuel — be it diesel, gasoline, propane or whatever — and through in-cylinder combustion with pistons, con-rods and crankshaft making it into rotary torque, Sturman's latest concept is to make the internal combustion engine into a directly generating high-pressure hydraulic pump using only the pistons.

To understand how this comes about, you need to understand Eddie Sturman. He's a genius and the father of the digital valve that has him in the Aerospace Hall of Fame. Sturman is responsible for the astronauts of the doomed 1970 Apollo 13 moon launch actually making it home. His digital valve in the fuel system, which draws no current in either latched open or closed position, meant the sorely depleted batteries after an electrical power failure had enough energy to get the mission home.

Sturman is about hydraulics and he is directly responsible for the hydraulic electronic unit injector technology that currently feeds International's diesel engines. His system provides, through hydraulic multiplication, the pressure to atomize the fuel and meet emissions standards.

Compared with the hydraulic pressure to fire the injectors, the opening and shutting of the valves in a four-cycle engine is child's play, hence the cross-country demo of an engine that had no camshaft. The truly remarkable thing about this demo is not the removal of the camshaft but the decoupling of the air and fuel handling processes of the engine from the position of the crankshaft. By eliminating the mechanical relationships between valve opening and crankshaft position, a designer can program any injection and air inlet and exhaust event.

The problem that Sturman sees in the acceptance of his concept is that engine designers think conventionally and don't exploit this potential. They basically mimic the usual sinusoidal motions from the conventional camshaft electronically, thereby failing to realize the significant gains in economy and emissions cleanliness — not to mention multifuel compatibility — these new freedoms from electronic valve controls make possible.

Were that not challenge enough, now the technology goes a step forward. There is no crankshaft to time against.

In the latest concept, pistons directly act on hydraulic cylinders. In turn, the hydraulics provide the upstroke to the pistons. But in the net balance, there is a net generation of pressure in the hydraulic system that provides power from the fuel — whatever it may be. Run the fan? Easy. Generate electrical power from an alternator. Not an issue. Run hydraulic motors at the wheels? But of course.

Again, we are limited by what we can imagine and tend to think of the system in terms of the rotating hardware of a conventional internal combustion engine. But dis-

persing with the crankshaft allows for independent piston movement, including shutting down cylinders. But not in the current model of letting them idle up and down pumping air. With the electronic control of the hydraulics, deactivated cylinders can be truly idle and carry no pumping losses.

I am not clever enough to see all the potential of Sturman's concept, but it is truly revolutionary. Or would that be un-revolutionary?

The real problem is that the technology exists to decouple the air and fuel management from the piston position, and piston position can be independently determined. That requires completely new thinking in the way that fuel and oxygen mix in the cylinder and how that chemical reaction is reacted and communicated to all the vehicle systems, whether heating, ventilation and air conditioning, the radio, the power takeoff, the transmission.

In a previous commentary in *Heavy Duty Trucking*, I wrote that Sturman had invented a new technology akin to inventing the concert piano but there was no music for it. He is going to have to write the concertos to exploit the versatility of his new instrument.

Sturman is a visionary, and his ideas are so far out there that most research and engineering facilities cannot change direction fast enough to accommodate the concepts. They may take bits and pieces of the available technology and realize extraordinary gains in performance and fuel economy as did International and Ford with the Sturman solutions to their injection system demands, but it'll be a big day when a major manufacturer really embraces some of the advanced concepts that come out of the Sturman Industries Woodland Park, Colo., think tank. **dp**