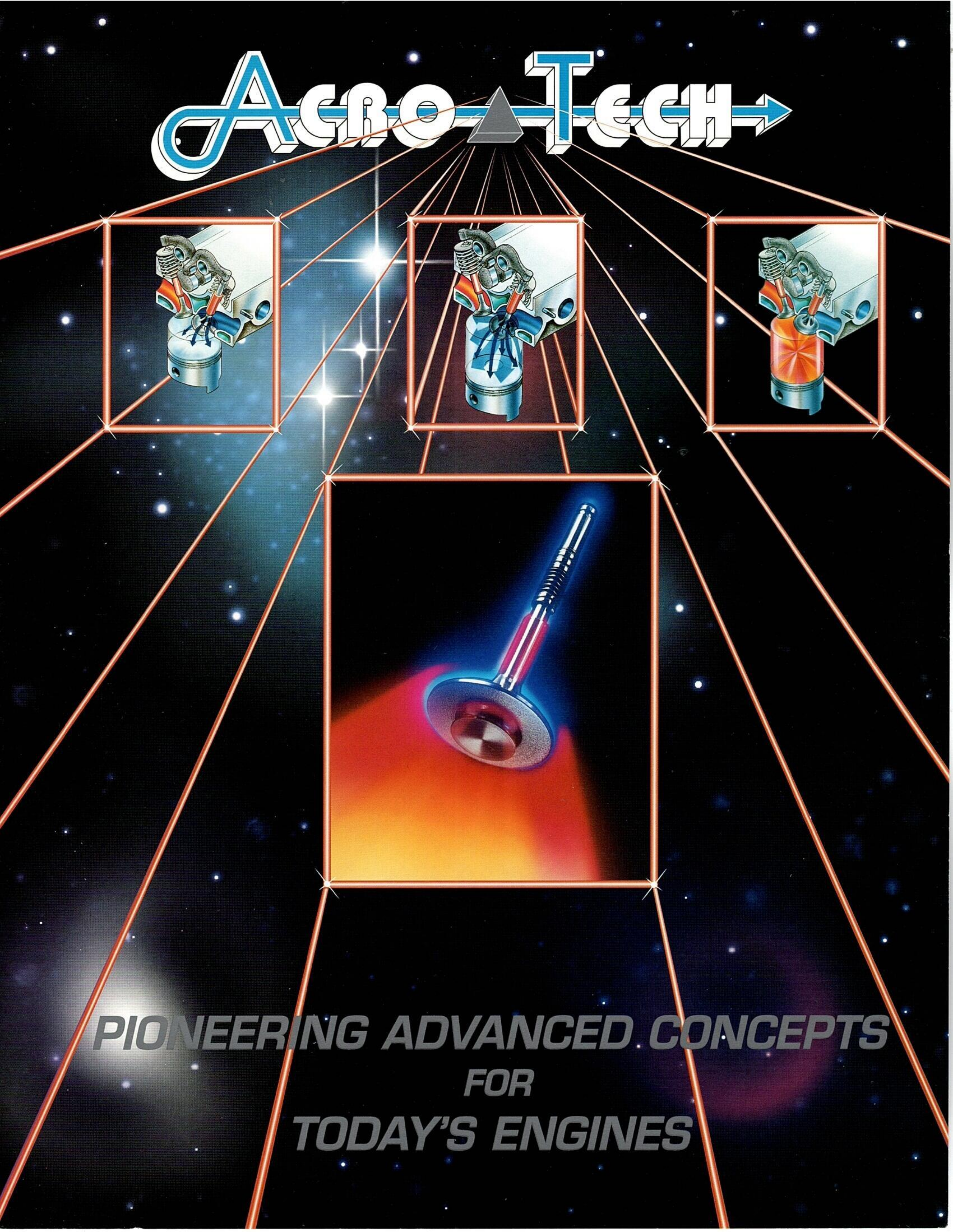
ACRO-TECH
PIONEERING ADVANCED CONCEPTS
FOR
TODAY'S ENGINES

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TECHNOLOGUE

BY RON GRABLE

ACRO-TECH'S VENTED VALVE

A VALVE-IN-VALVE DESIGN TO INCREASE VOLUMETRIC EFFICIENCY

An internal-combustion engine is essentially an air pump, and its power output is a function of how much air can be processed through it. Innovations like multiple valves, tuned intake and exhaust systems, and variable valve timing are all mechanical means of increasing the amount of air an engine can breathe during its intake cycle. Turbochargers and superchargers also are pumps, external to the engine, which increase airflow by force-feeding intake air at higher (than atmospheric) pressure.

Despite all the mechanisms to increase airflow, the single most significant intake restriction remains the intake valve itself, especially at low valve lifts. The intake charge flowing down the induction port has its highest kinetic energy at its center, yet as it reaches the head of the intake valve, all the incoming airflow must squeeze out around the periphery of the valve to enter the combustion chamber. This causes the highest energy portion of the intake flow to stack up on the back of the valve head, creating a pressure that opposes intake flow.

Acro-Tech Inc., a small research company in Oregon (503/531-9394), has come up with an elegant solution to this problem, which, according to its preliminary testing, promises some significant gains for the internal-combustion engine. Acro-Tech replaces the standard intake valve with a vented, two-stage valve, which is actually a valve-in-valve design. Entirely contained within the head and stem of a conventional intake valve, it features a small titanium inner valve, controlled by self-contained coil springs. The small springs are sized so that the opening point, lift, and closing point of the inner valve is determined by the difference in pressure between the intake tract and the combustion chamber. At low-throttle openings and low rpm, the pressure difference is small, causing the inner valve "timing" to be conservative. Full throttle and high rpm cause it to open sooner, with more lift, and close later. Since opening and closing of the inner valve is a function of engine demand, it can be thought of as the quintessential variable valve timing system.

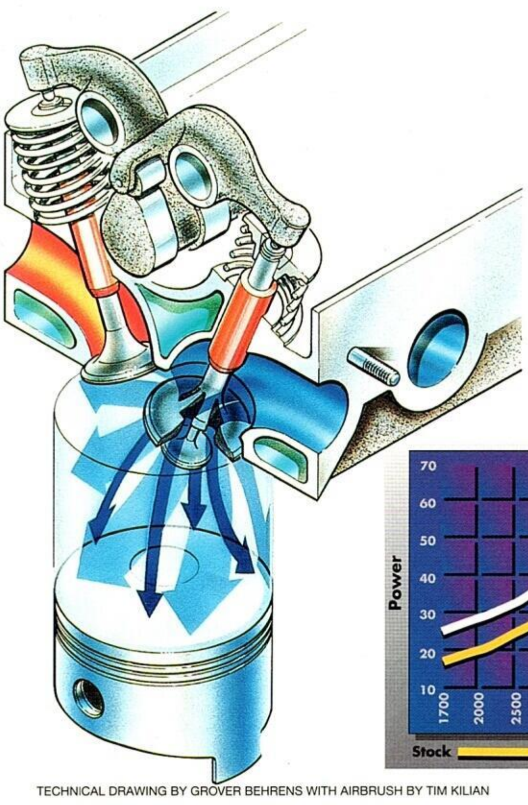
When the inner valve is open, incoming air can flow through vents in the outer valve head directly into the combustion chamber, as well as around the periphery of the conventional valve head. This increased intake flow through the inner valve not only increases volumetric efficiency, but enhances turbulence and helps atomize fuel droplets for improved flame propagation. Acro-Tech claims the more homogeneous mixture burns much faster, allowing spark advance to be reduced from the typical 35 degrees BTDC (before top dead center), to 15 degrees BTDC, this decreases negative work on the crankshaft prior to TDC on the power stroke. This faster burning also means there's less residual gas released into the exhaust at the end of the power stroke, which reduces emissions.

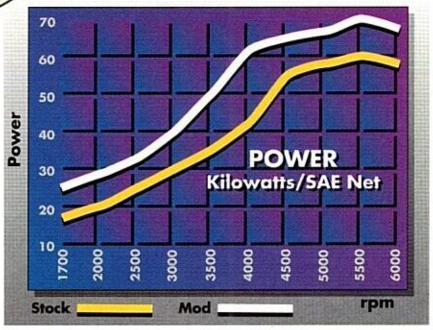
First testing of the vented valve concept was done at the Vehicle Research Institute at Western Washington University, in Bellingham, Washington. The vented valves were installed in an '89 2.0-liter Mitsubishi SOHC two-valve engine. Installation required only that the standard valve guides be reamed 1 millimeter oversize, to accommodate the slightly larger valve stems of the vented valves. Ignition timing was reduced as mentioned above, but in all other respects, the engine was standard.

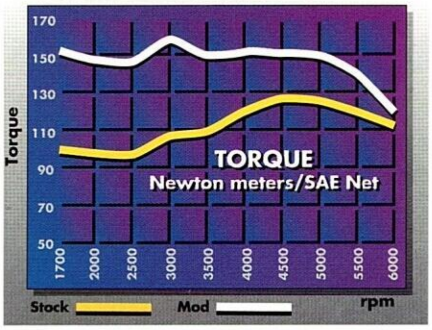
Since this was the first test of the vented-valve concept, no changes were made to the engine computer to optimize the fuel/air ratio for the increased airflow. In spite of that, the gains were significant. Power was increased across the entire rev range an average of approximately 35 percent, and torque increased even more. Of particular interest is the flatness of the torque curve with vented valves. Flat torque curves are the Holy Grail for engine designers because they make powerplants highly flexible, improving performance at low engine speeds, where they're more fuel efficient.

The potential of this vented-valve concept seems enormous. Further work to tune the engine to better accommodate the valves, and additional development of the valve itself, hint at greater improvements. Adapting vented valves to four-valve layouts could perhaps be the most promising application of all, addressing the four-valve layout's typical poor torque at low engine speeds.

It's just such innovations as these that continue to breathe new life into the internal-combustion engine. *MT*







TECHNICAL DRAWING BY GROVER BEHRENS WITH AIRBRUSH BY TIM KILIAN

ARROYO DESIGN