Est. 1977

HANSEN ENGINE™

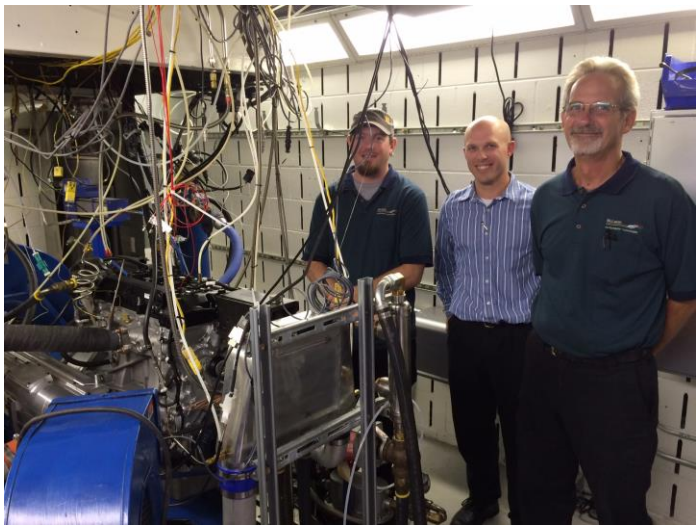
TECHNOLOGIES

Introduction to the new Hansen Supercharger®

Summary: Hansen Engine Corporation has developed a variable-displacement mechanically-driven supercharger to enable cost-effective engine downsizing with equal or better fuel economy than exhaust-driven turbocharging. **It does so without 'turbo lag' or expensive auxiliary drives to reduce turbo-lag**. This advancement is made possible by its variable-displacement feature which eliminates conventional supercharger inefficiency during the frequent 'partial boost' drive cycle conditions. Data from independent testing at Ricardo shows that it reduces drive power losses by 35-50% compared to a conventional supercharger during the US-EPA drive cycle conditions. On-engine dynamometer testing at McLaren Performance Technologies provides further independent confirmation. The Hansen Supercharger® system provides a practical and cost-effective single-device boost system for which the **instant throttle response and improved drivability** characteristics of superchargers are no longer handicapped by the fuel economy penalty of conventional superchargers relative to turbochargers.

The Hansen Supercharger® Technology presents an innovative new supercharging technology invented and patented by Hansen Engine Corporation which has now been fabricated and laboratory tested. The primary distinguishing feature of this new supercharging system is "continuously variable displacement," which contrasts with conventional fixed-displacement superchargers. Laboratory measurements have established that the new variable displacement system saves 35-50% of the power of a conventional same-sized supercharger to operate at the speeds and boost pressures that dominate the US-EPA automotive driving cycles. These power savings directly reduce fuel consumption, and the Hansen Supercharger® enables a greater degree of engine downsizing which allows for further fuel savings.

Conventional superchargers are FIXED-displacement devices which cannot be varied. If conventional fixed-displacement superchargers are sized to meet peak air demands at low engine speeds, then excessive air will be produced and discarded at ALL other engine conditions with associated wasting of energy. While smaller sizes would reduce this energy loss, these under-sized superchargers would not be able to meet the peak demands of the driver at low engine speeds. The Hansen Variable Displacement Supercharger® efficiently processes only the necessary quantity of air without excess under all engine conditions, and is therefore more fuel efficient.



McLaren Performance Technologies' staff in their dynamometer engine test cell (Hansen Supercharger® boosting a 2.0 liter Ford EcoBoost® 4-cylinder engine)

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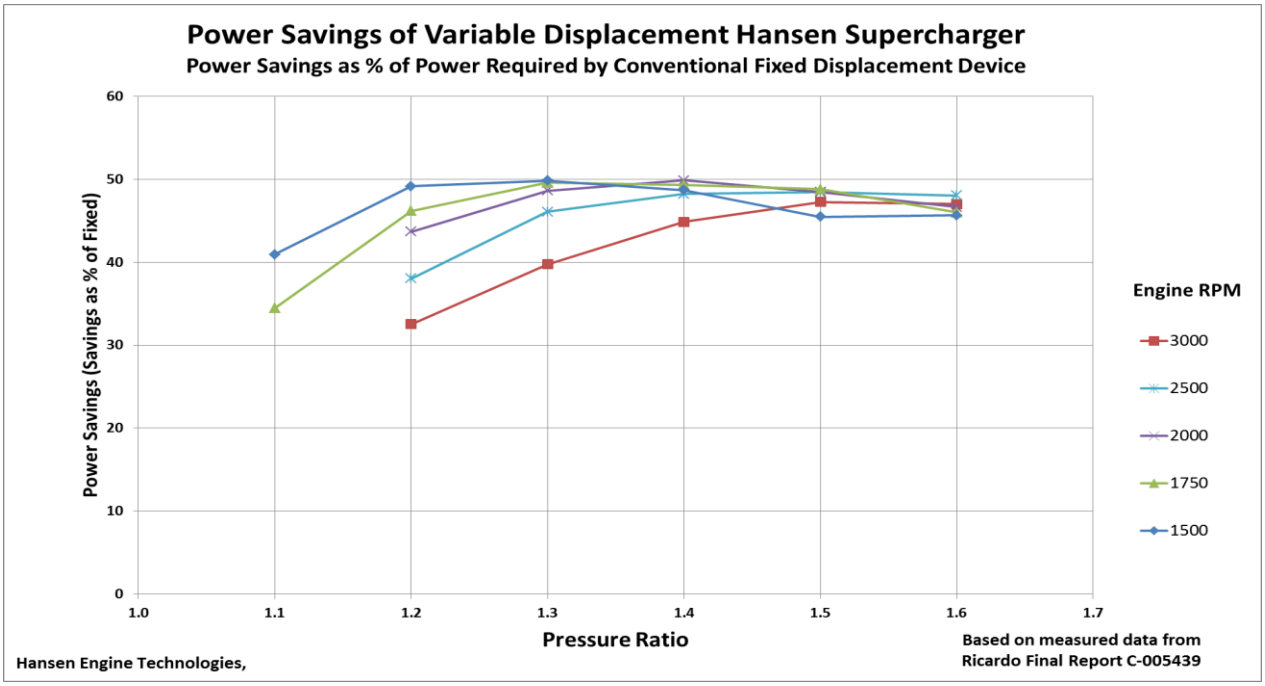
Hansen “Variable Displacement Supercharging” complements the current industry trends in engine down-sizing and engine down-speeding. The new supercharger provides important improvements in throttle response and fuel economy. Engine boost systems have historically targeted high-performance niches. In contrast, the Hansen technology is focused on fuel economy and drivability for the normal drive cycles.



Shaft Power Savings at Speeds and Boost Pressures
Typical of US-EPA Drive Cycle Conditions

The new supercharger has been successfully tested by two independent laboratories. First, “flow-bench” testing at Ricardo indicated that the Hansen Variable-Displacement Supercharger® provided savings of 35-50% in shaft power to operate at speeds and manifold pressures typical of the US-EPA drive cycles. This reduction is measured in comparison to a conventional “fixed-displacement” supercharger sized to provide the same airflow capacity that is required to meet the required engine low-speed torque demand. Second, “engine-mounted” dynamometer testing was successfully completed at McLaren Performance Technologies, an independent Detroit testing laboratory.

Vehicles and engines designed specifically for supercharging rather than turbocharging can benefit from fuel-saving factors such as improved axle ratios and transmission shift schedules to take full advantage of the near-instantaneous transient response of the supercharged engine. The VDS supercharged engine offers automakers a significant fuel-saving option that is not available from turbocharged engines in the form of an increased compression ratio. An automaker may opt to limit the low-speed torque capacity of the engine in order to allow an increase in the compression ratio of the engine, thereby improving fuel economy. This tradeoff is not practical for turbocharged engines because the transient torque available is already lacking during vehicle acceleration due to turbo-lag. Given the rapid transient response of the supercharged engine, the vehicle acceleration will remain superior to that of the turbocharged vehicle, even with the election to set a limit on the low-speed torque capacity of the supercharged engine to improve the fuel economy.

A vehicle designed to take full advantage of the supercharged engine can meet or exceed a turbocharged vehicle’s fuel economy when operating at the variable speeds and manifold pressures typical of the US-EPA drive cycles. This presents the opportunity for a significant shift in the boost system preferences of the auto industry. The Hansen Supercharger® system provides a practical and cost-effective single-device boost system for which the instant throttle response and improved drivability characteristics of superchargers are no longer handicapped by the fuel economy penalty of conventional superchargers relative to turbochargers.

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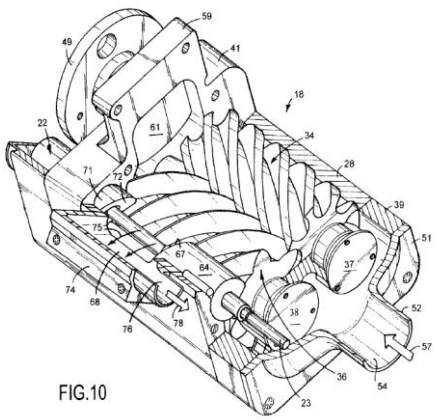


FIG.10

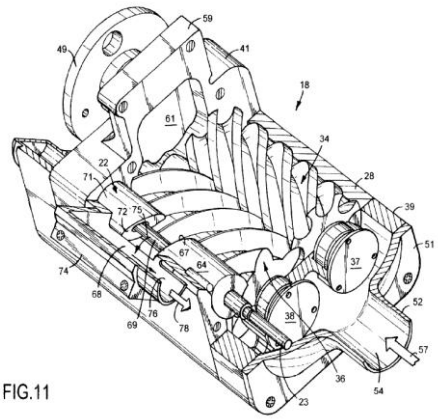


FIG.11

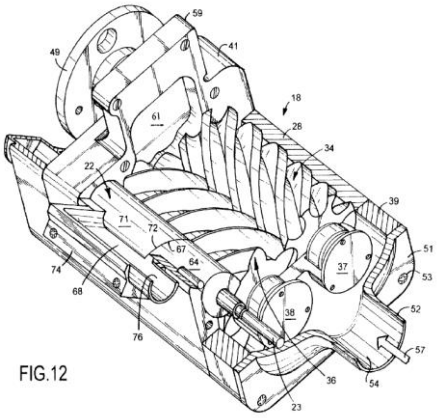
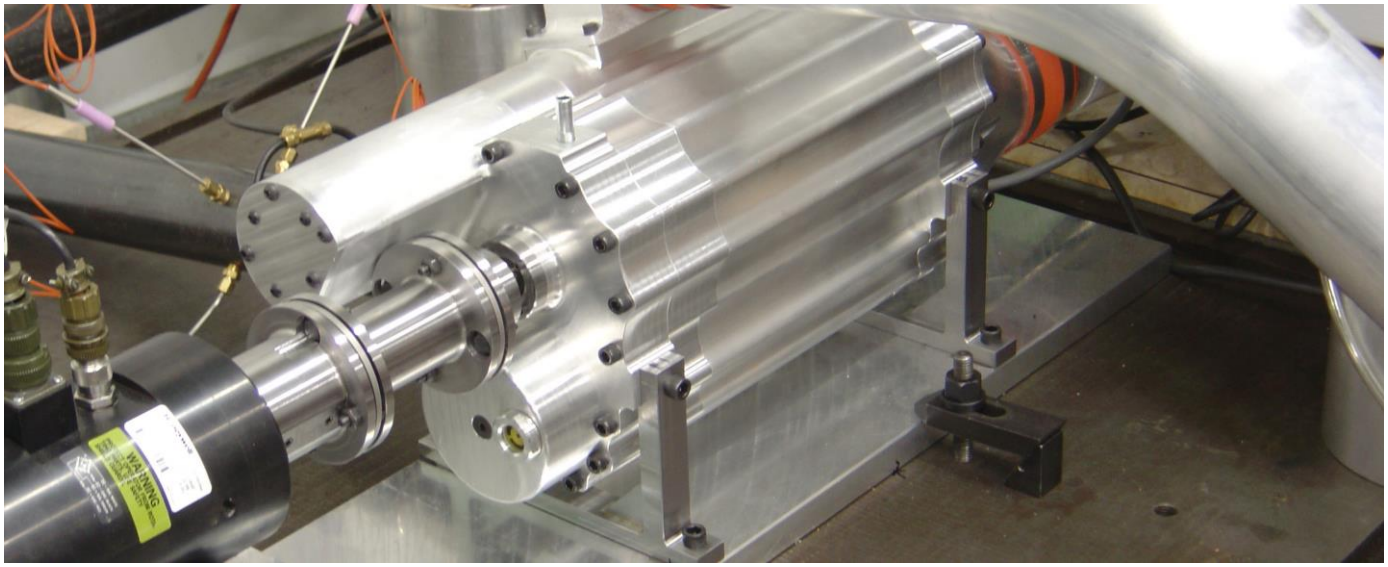


FIG.12

Hansen Continuously Variable Displacement Supercharger® US Patents issued:
7726285, 8256403, 8302401, 8539769, 8813492, 9797299, D792471, and D778322
Patents have issued in China, Korea, Japan, and Canada.
European allowance was received in April 2018.



The Hansen Supercharger® featuring "Continuously Variable Displacement"
Undergoing Laboratory Testing per SAE J1723 Specifications

Superchargers are available for inspection and demonstration once suitable Non-Disclosure Agreements are in place. A "concept demonstration" plastic replica could also be made available. The Company's corporate law firm is Briggs & Morgan which is responsible for NDA accommodations. Next steps may be initiated by contacting either of the corporate officers below:

Robert D. Hansen
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