Special Feature | **Turbochargers**

THE DYNAMISM OF TURBOCHARGERS

P02-03 : The TD015 (in technician's hands), the smallest-class car turbocharger fitted in light-class car engines, and the MET90MA (behind technician), the largest-class marine turbocharger for container vessel diesel engines. Medium- and large-sized marine turbochargers are produced at the Saiwaimachi Plant of Nagasaki Shipyard & Machinery Works (Power Systems), while small turbochargers for passenger cars and other uses are produced mainly at Sagamihara Machinery Works (General Machinery & Special Vehicles), but also in plants overseas.
Nagasaki Shipyard & Machinery Works, Nagasaki Prefecture

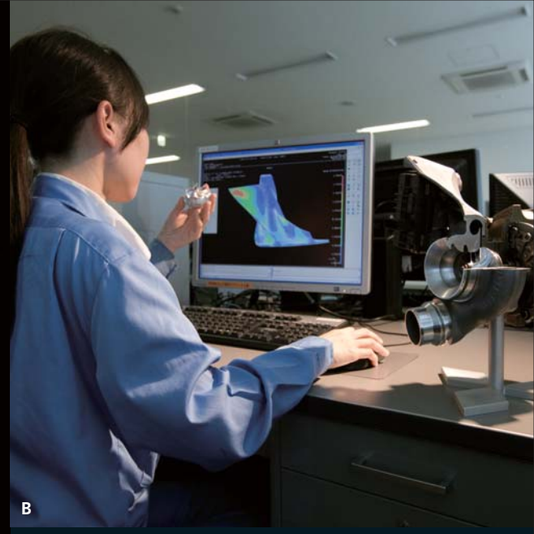
Front cover : Turbocharger for passenger car engine
Sagamihara Machinery Works, Kanagawa Prefecture

The turbocharger — a compelling response to harsh economic times and environmental standards

Most people associate turbo engines with high horsepower sports cars. However, the engines of most trucks, buses, construction machinery, generators and ships are also powered by turbochargers. The future development of car engines depends heavily on turbochargers. Turbochargers are essentially supercharging systems that efficiently burn fuel in a piston chamber by pumping large amounts of compressed air to the engine. As such, they are now attracting keen attention as formidable responses to current economic and environmental issues because of the increased engine power, improved fuel consumption and reduced emissions that they are capable of delivering in downsized engines.

PRODUCTS THAT DEFY EXPECTATIONS

A



B

A : Turbocharger performance being tested while fitted in an engine. The photo shows a gasoline engine with a rated speed of 6,000rpm being operated at 5,000rpm. The outside of the engine is scorched red due to prolonged exposure to extremely hot exhaust gases, with the turbine inlet temperature reaching 900°C. There are now calls for gasoline engines to be fitted with turbochargers that can withstand exhaust gas temperatures of up to 1,050°C.
Sagamihara Machinery Works, Kanagawa Prefecture

B : After the basic design has been completed at the Nagasaki Research & Development Center, the Turbocharger Engineering Department of Sagamihara Machinery Works uses 3D imaging to analyze the thickness and angles of the blades, the most important components of the turbocharger's compressor wheel. The 3D imaging allows engineers to simulate the optimal balance between the conflicting requirements of strength and lightness (thinness), while also taking the client's requests into consideration.
Sagamihara Machinery Works, Kanagawa Prefecture

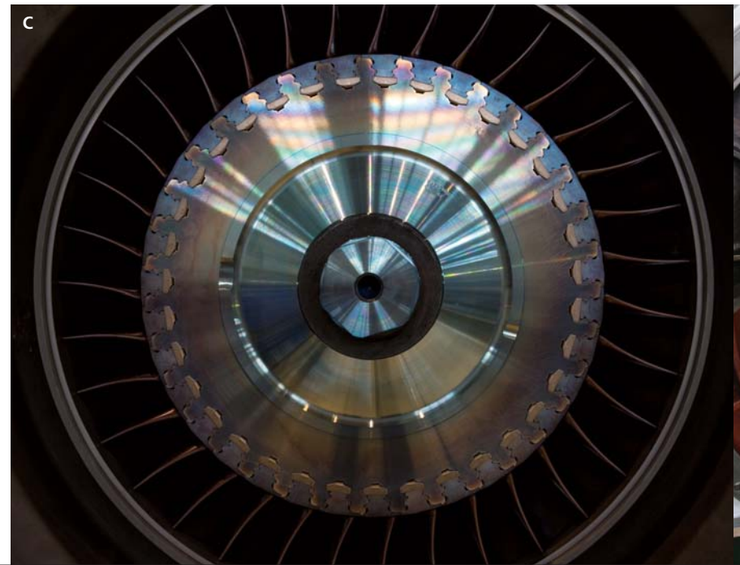
C : The turbine rotor used in the MA90 model is shining proof of MHI's world-class engineering capabilities in the development and production of high-speed rotating machines. The meticulous design of the turbine rotor and compressor wheel for both ships and cars is handled by the Turbomachinery Laboratory of the Nagasaki Research & Development Center.
Nagasaki Shipyard & Machinery Works, Nagasaki Prefecture

D : Reduced-size model of the hybrid MET42MAG turbocharger with built-in generator that produces electricity from the engine's exhaust gas, providing the ship with all the electric power it needs during its voyage. MHI expects the increasing popularity of eco-ships to drive up demand because of reductions in fuel consumption and CO_2 emissions that it delivers.
Nagasaki Shipyard & Machinery Works, Nagasaki Prefecture

Development and production of turbochargers require experience, resources and creativeness

The development of turbochargers faces never-ending challenges due to the vital role they play in defining engine performance. For example, developers of turbochargers for car engines are expected to satisfy strict criteria in terms of performance, quality, cost and delivery dates, while also liaising closely with the automakers during their engine development process.
This also involves providing expert engineering support to enable them to meet their own customers' demanding requirements regarding engine output characteristics and positioning within the vehicle.
They must also have a flair for identifying the needs of their time as is evident in marine turbocharger (MET) development. This development attitude is epitomized by hybrid turbochargers that use engine exhaust gas to generate electricity and by VTI turbochargers* that are fitted with an innovative variable mechanism.

*VTI (Variable Turbine Inlet) turbocharger: A variable turbocharger with an exhaust gas nozzle inlet area that can be adjusted to two different settings. Narrowing the nozzle inlet area increases the boost pressure of the exhaust gas, thereby enabling faster rotation of the turbine when the engine is running at low speeds and delivering improved fuel efficiency.



C

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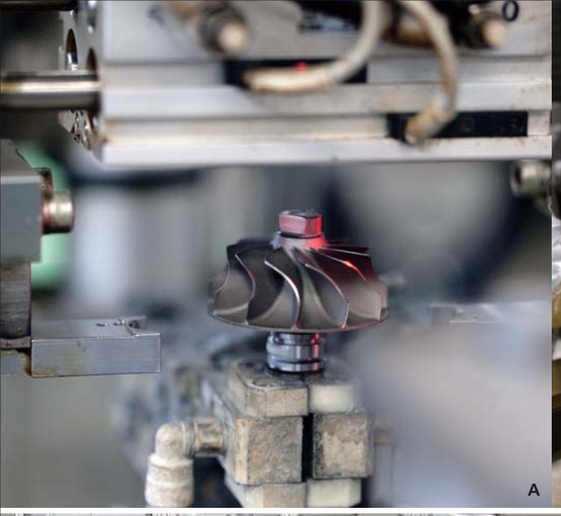


A: Using an MHI-manufactured cleaning device to remove dirt from the previous process.

B: Cartridges that have been manufactured and assembled on an automated production line.

C: VIsual inspection of turbine rotors straight from the automated production line.

D: Part of the automated production line that assembles cartridges, the core components of turbochargers. The various tasks of manufacturing, assembling, measuring and inspecting turbine rotors and compressor wheels are efficiently performed by robots working at their assigned stations around the clock. The relentless accumulation of improvements has brought it to a level of automation that is unmatched anywhere in the world.

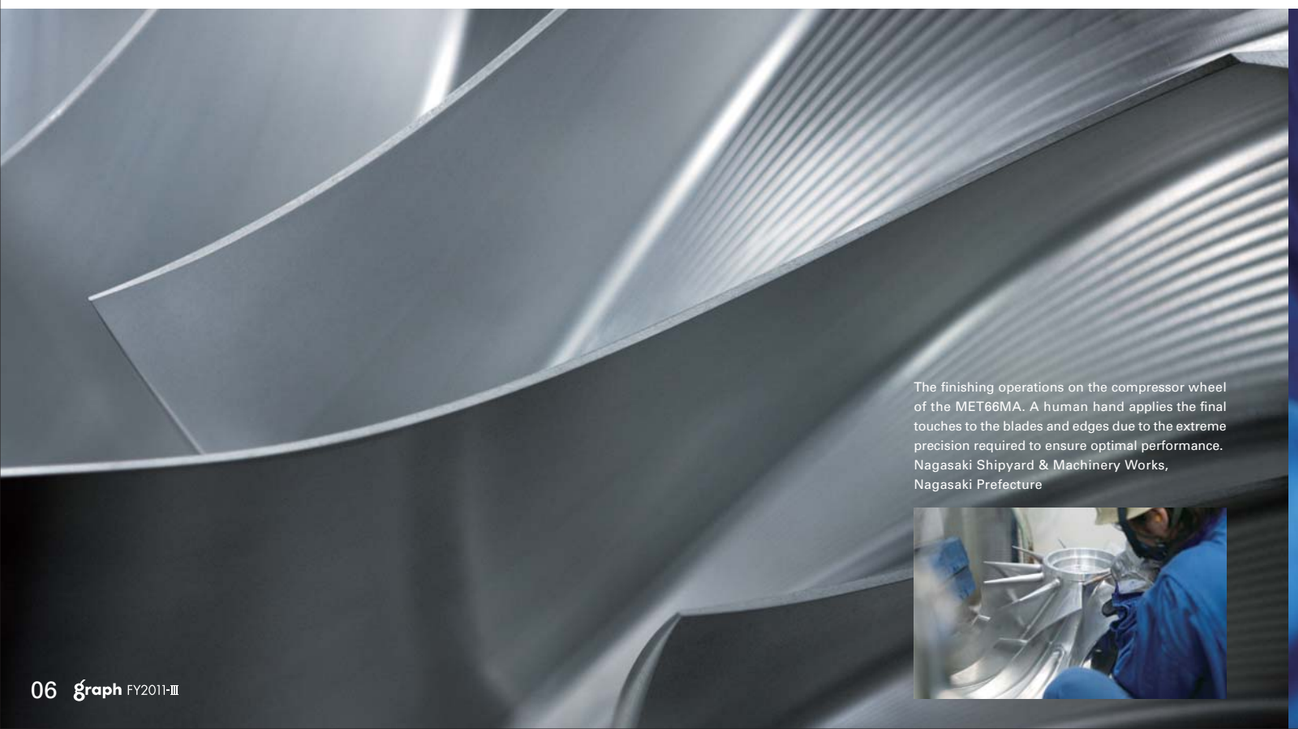
(Photo A~D: Sagamihara Machinery Works, Kanagawa Prefecture)

PURSUIT OF QUALITY

Exploiting craftsmanship of man and machine

With an annual production level of passenger car engine turbochargers in excess of 4.5 million units, accounting for more than 22% of the global market, MHI is aiming to capture the world's top share. This growth has been supported by complete automation in the production of cartridges*, the core heart-like component of a turbocharger.
By deploying automated production lines at overseas plants and standardizing production techniques, MHI has created a global mass production structure that consistently delivers extremely high quality.
At the other end of the spectrum, the production of huge marine turbochargers that can stretch beyond 3.5m requires elaborate craftsmanship that draws on the techniques and experience of experts. MHI's unique harnessing of the creative capabilities of man and machine allows it to produce turbochargers of all sizes and for all purposes.

* The core portion of the turbocharger that houses the turbine rotor — with rotation powered by the engine's waste heat, and the compressor wheel, which pressurizes the inflow air.



The finishing operations on the compressor wheel of the MET66MA. A human hand applies the final touches to the blades and edges due to the extreme precision required to ensure optimal performance.
Nagasaki Shipyard & Machinery Works, Nagasaki Prefecture

The labyrinth seal fins prevent gas from entering the turbine rotor. The fins, rotating at high speeds and temperatures, engage within the slightest clearance of less than 1mm. Experienced workers manage the assembly precision to 0.01mm levels, using special measuring tools and clearance gauges that they themselves have refined.
Nagasaki Shipyard & Machinery Works, Nagasaki Prefecture

The compressor wheel of the brand new MET53MA that rotates at high speeds. During sailing, it operates at 17,800 rpm. In other words, the leading edge of its blades maintains a speed of 480 meters/sec, surpassing the speed of sound. Nagasaki Shipyard & Machinery Works, Nagasaki Prefecture

CARVING OUT A BRIGHT FUTURE

High Hopes for Heightened Turbocharger Technology around the World

Turbochargers are assuming increasing significance at a time of mounting concern over environmental protection and energy conservation. The amplified power of turbo-fitted engines allows them to become more compact without diminishing basic engine performance. The current downsizing of turbochargers, particularly for engines of European cars, has been driven by reduced fuel consumption and the environmental benefits derived from the reduction in the amount of toxic exhaust gas. Although turbochargers have always been indispensable for marine diesel engines, the increased demand for fuel efficiency is also shining the spotlight on next-generation marine turbochargers that can deliver longer sailing distances.

Furthermore, both the automotive and shipping industries are facing stricter environmental regulations. In the automotive industry, for example, it is generally believed that passenger cars not fitted with a turbocharger will fail to meet the next European emissions standard (Euro VI) for diesel vehicles that will be implemented in 2015. Turbochargers can only benefit from this backdrop of tightening regulations.

Turbochargers Continue MHI's Vibrant Tradition of Reliability in Rotating Mechanisms

MHI boasts a lineup of turbochargers covering a wide variety of engines for passenger cars and commercial vehicles to ships and aircraft, with each one carrying its own history. However, the basic structure of turbochargers shares many similarities with the gas turbine and the jet engine, two products that belong to MHI's realm of expertise. You only have to look at MHI's aerodynamically designed turbine rotors and compressor wheels to realize that MHI has condensed its wealth of experience and knowledge of high-speed rotating machines into its turbochargers. The low incident rate of its turbochargers after they have been fitted in cars and ships provides further evidence of their quality. This quality is also validated by users' high praise of the turbochargers. MHI's tradition of reliability lives on.

Widening the Global Expansion of High-Quality Turbochargers

Turbochargers are global products with worldwide demand, and MHI's turbochargers have seen remarkable growth in recent years. The client base for its turbochargers for car engines now extends to automakers in Europe, America and Asia, with foreign companies accounting for more than 80% of the demand. A global network of offices and production centers is essential for maintaining close cooperation with clients during the development process and for the fulfillment of just-in-time delivery and cost requirements. MHI has therefore set up production centers in the Netherlands (MEE), Thailand and China and also built a network of parts suppliers in peripheral regions. This amounts to a global production and distribution structure capable of consistently delivering products of the same high quality as Japanese plants. With its marine turbochargers now being supplied to the top three manufacturers of marine diesel engines (including MHI's UE engine), MHI has concluded licensed production agreements with major Korean companies in order to supply to the world high-performance turbochargers created using Japanese technology.

MHI is also dedicating itself to the development and production of ground-breaking higher value-added turbochargers, such as variable two-stage turbochargers for diesel engine cars that provide all-speed performance, and hybrid turbochargers that meet the growing demand for eco-ships in the shipping industry. These innovative products are expected to make significant contributions towards the creation of a more environmentally conscious and energy-saving society. MHI even hopes that the turbocharger itself accelerates the advent of a sustainable society.