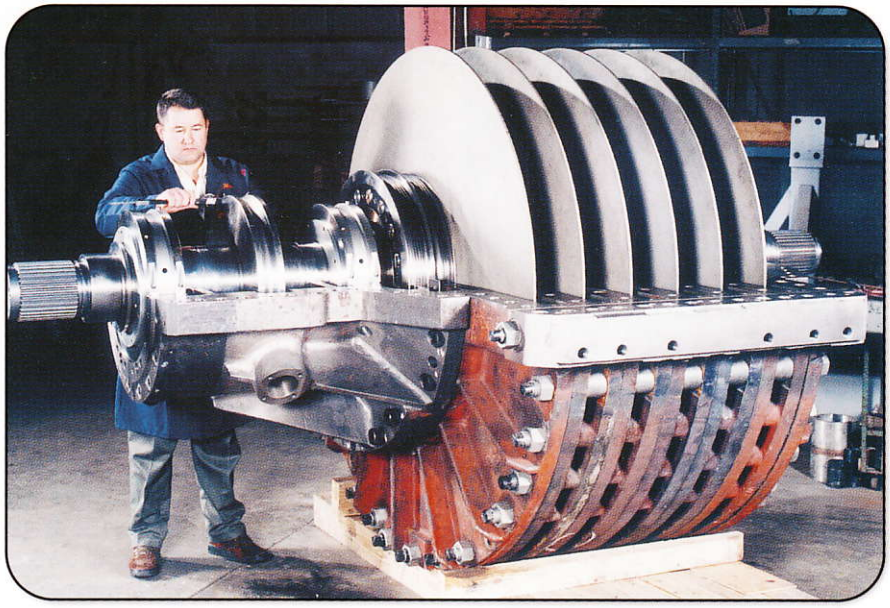
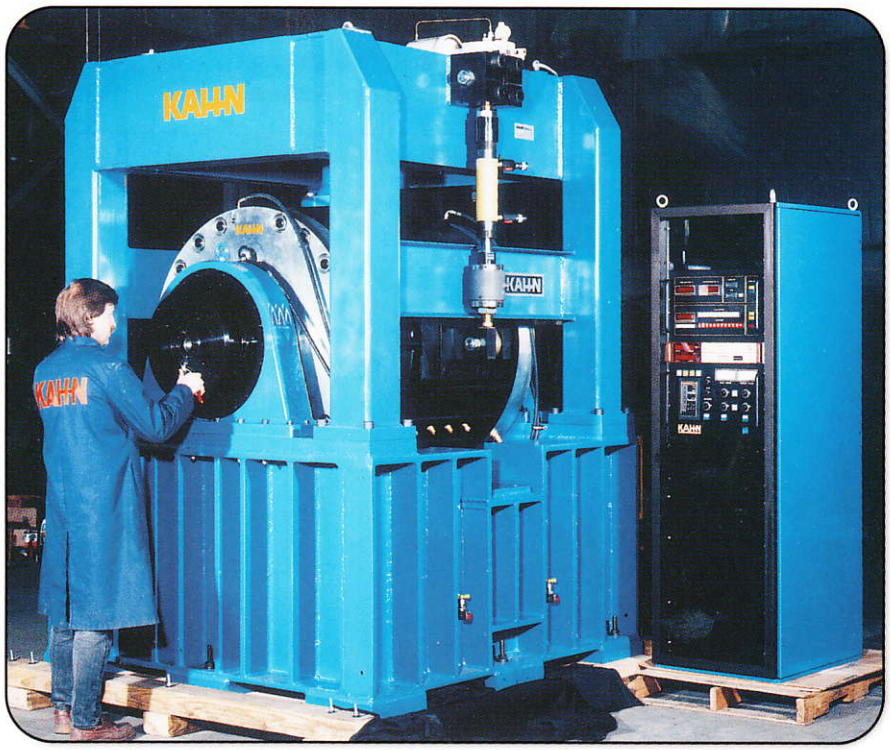
Hydraulic Dynamometers for Testing Gas Turbines





(Above) Inspection during assembly of a Kahn Industries Series 400 hydraulic dynamometer. Constructed from a special steel alloy, the rotor assembly is designed for long life, while enduring both water exposure and mechanical stress. The smooth disc rotor has a diameter of 1600 mm and weighs 8200 kg. (Below) A Kahn Series 400 dynamometer being prepared for shipment. This unit contains a built-in calibration system for maintaining torque measurement accuracy. The accompanying control cabinet features an automatic dynamometer control and alarm monitoring system.

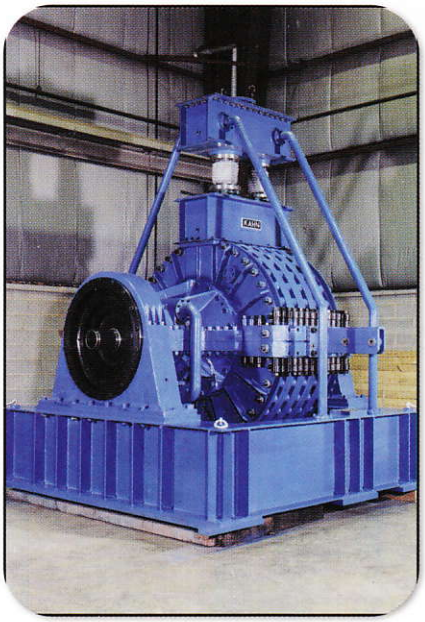
What do the engine test departments of ABB Alstom, General Electric, Rolls-Royce Allison, Pratt & Whitney Canada, Samsung, SNECMA, Turbomeca, the U.S. Army and U.S. Navy have in common? They all use Kahn Series 400 hydraulic dynamometers for development and production testing of their high-speed gas turbine engines.

Kahn Industries' introduction of the Series 400 smooth disc dynamometers in the early 1970s was an important step forward in dynamometer technology. At the time, there was a clear need for high-speed power absorbers that would provide long service life under severe operating conditions.

Series 400 hydraulic dynamometers are in service with gas turbine manufacturers, research organizations and engine overhaul facilities in North America, Europe, Asia and South America, testing industrial and marine gas turbines, high-speed helicopter turboshaft engines and high-speed experimental turbines.

In contrast to vane or perforated disc type machines, the Series 400 smooth disc dynamometers absorb power by viscous shear on the rotor and stator surfaces. This power absorption process inherently discourages cavitation inception and helps eliminate the need for frequent replacement of the power elements, according to the company. For this reason, the Series 400 high-speed hydraulic dynamometers carry a special 2000 hour/24 month warranty against cavitation damage of the power elements. Operating experience in the field has shown that the actual life of power elements has been well in excess of 10,000 operating hours, the company stated.

One of Kahn's first smooth-disc dynamometer applications was a model 406-160 for development, endurance and production testing of LM2500 industrial and marine gas turbines. The U.S. Navy uses the LM2500 to power the majority of its surface ships, including cruisers, destroyers, frigates and supply ships. It is also used by other turbine manufacturers, such as Dresser Rand, Fiat Avio, Ishikawajima-Harima, MTU and Nuovo Pignone, as a power plant for power generation, offshore platform, gas pipeline and marine applications. The original specifications called for a hydraulic dynamometer capable of performing a 1000-hour continuous endurance test. Commissioned in 1971,



Used for development testing of industrial and marine gas turbines, this Kahn dynamometer is rated 60 000 kW at 4500 r/min and weighs over 36 000 kg.

this dynamometer was capable of absorbing 37 000 kW at speeds up to 4500 r/min. At the time, with a dry weight of over 36 000 kg, it was the largest hydraulic dynamometer manufactured in the United States. When the dynamometer was finally replaced with a new and more powerful Kahn dynamometer after 20 years of continuous service, it had logged over 27 000 operating hours still using its original power elements.

Based on the success of its base-mounted smooth disc dynamometers for industrial and marine gas turbine applications, Kahn developed the Series 404 flange-mounted dynamometers for smaller high-speed engine test applications. With a power range of up to 2800 kW and a speed range up to 30 000 r/min, the Series 404 are used for performance testing of all current helicopter turboshaft engines, including the General Electric T58 and T700, Honeywell/Rolls-Royce Allison T800, Pratt & Whitney PT6C, Rolls-Royce Gnome, Rolls-Royce/Turbomeca/MTU RTM322 and Turbomeca Makila. Because test specifications for turboshaft engines require simulating the inertia of the helicopter rotor during dynamic test procedures, the dynamometers have to be equipped with a flywheel. The Series 404 flange mount design configuration permits mounting the dynamometer directly to the flywheel housing. The design also helps save test cell space, minimizes drive shaft length and eliminates the drive shaft alignment procedures, the company said.

The Series 404 dynamometers can also be easily adapted for special test requirements, such as attitude testing and gyroscopic testing of turboshaft engines. For attitude testing, the engine, dynamometer and flywheel are installed in a variable attitude test stand where they are operated in all attitude positions from horizontal to vertical, and at large roll angles. This test capability permits engine manufacturers to simulate actual flight conditions in the test cell. For gyroscopic testing, the engine, dynamometer and flywheel are mounted on a rotating platform. While operating at full speed and various power levels, high gyroscopic loads are produced by the rotation of the platform. This test cell procedure permits simulating gyroscopic loads, imposed on the engine during actual flight maneuvers.

