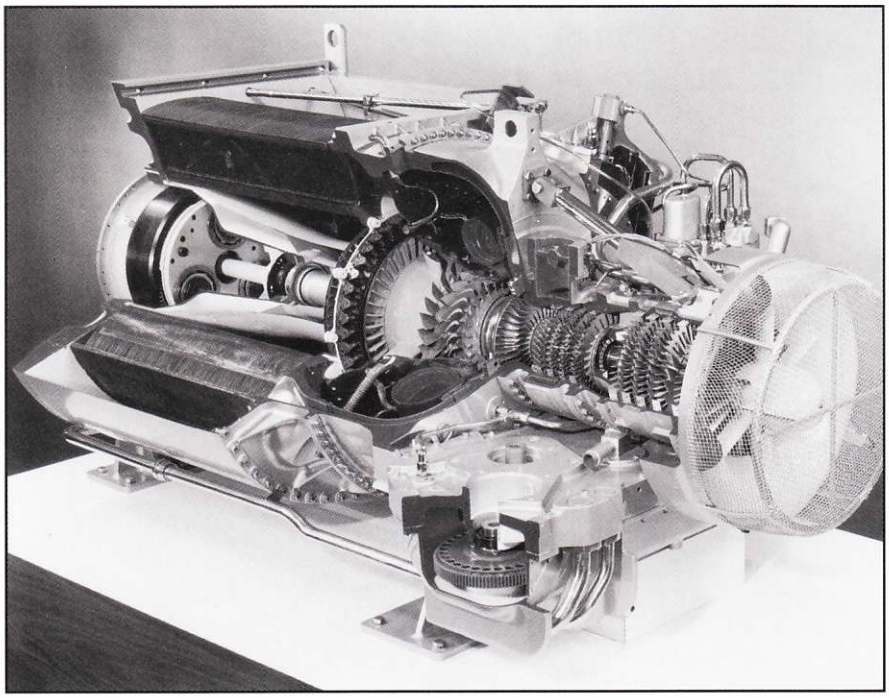


Subject of overhaul and testing by MIP at the Mainz U.S. Army depot, Textron Lycoming's type AGT1500 recuperated gas turbine from the M1 Abrams tank.

TESTING BATTLE TANK GAS TURBINES

OVER the last 12 years, hydraulic dynamometers from Kahn Industries, of Wethersfield, Connecticut, U.S.A., have been used at an overhaul facility in Germany to test more than 2000 Textron Lycoming AGT1500 recuperated gas turbines used in the U.S. Army's M1, M1A1 and M1A2 "Abrams" main battle tanks.

The gas turbines are tested by MIP, a company entrusted with the overhaul of engines and transmissions from a range of U.S. Army vehicles. The company operates a total of five Kahn dynamometers at the U.S. Army Depot in Mainz, in three gas turbine test cells. Identical dynamometers are used at the U.S. Army Depot in Anniston, Alabama, U.S.A., making the Kahn system the only one used by the U.S. Army for testing Abrams tank gas turbines.

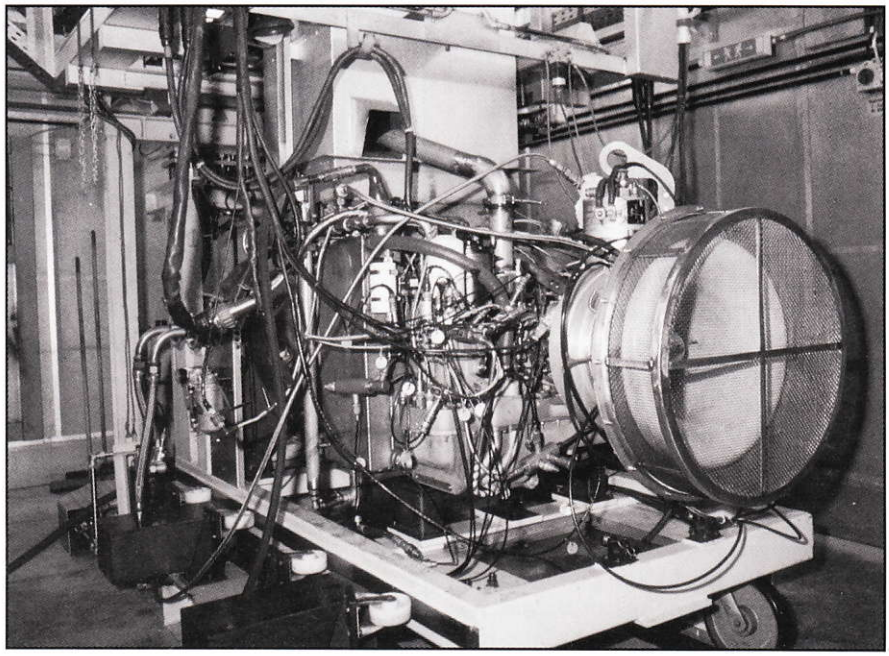
In 12 years of testing the AGT1500 gas turbine, reports Otto Helbig, head of engine and transmission overhaul in Mainz, no problems have been experienced with the dynamometers, nor has any gas turbine overhauled by MIP or tested on the dynamometers even been the subject of a complaint by the U.S. Army.

A three-shaft design, the Textron Lycoming AGT1500 gas turbine uses a two-stage power turbine driving an epicyclic reduction gear through which power is transmitted to the Allison X100-3B transmission. The free power turbine allows the transmission's torque converter to remain locked over a wide speed range to reduce parasitic power losses. In a space saving design, the exhaust heat recuperator is located around the power turbine-epicyclic reduction gear and connecting shaft. The horizontal spur gear at front right is part of a train including the oil pump drive and starter motor input. Power output is 1120 kW. At maximum output the power turbine speed is 3000 r/min, the low pressure compressor speed is 33 500 r/min and the hp compressor speed is 43 500 r/min.

At the depot, gas turbines requiring overhaul arrive from and are returned to U.S. Army combat units either separately or as part of the M1 tank's power pack, which includes the transmission, cooling system and other ancillaries.

Given the imporance of the Abrams tank to European defense over the past twelve years, a philosophy of reliability-centered maintenance underlies the overhaul procedures of the gas turbines. On arrival at the depot, a series of visual checks is made to establish the component condition and obvious faults. Gas turbines with such faults or having components outside tolerance are automatically dismantled for overhaul. An overriding inspection criterion, dictating investigative dismantling, is metal contamination of the lubricating oil.

Where all inspected components are within tolerance, and obvious faults can be rectified without disassembly, the gas turbine is subjected to a severe



View of the U.S. Army gas turbine test cell in Mainz, Germany, showing the Kahn dynamometer attached to the rear of a palletized test piece. The test piece is the assembled gas turbine and transmission module from the M1 tank.

15-stage, three-hour diagnostic test cycle on the dynamometer, which is designed to simulate extreme battlefield conditions. This test counts as the final test procedure if all criteria are met.

Given the permissible re-use of partly worn, but in tolerance parts, the U.S. Army's criterion for overhauled AGT1500 turbine performance is 90-95% of the manufacturer's rated output. Primary power measurement is based on torque indication from the strain gauge on the dynamometer support. Commenting on the 90 to 95% performance figure, John Masly, chief mechanical engineer overseeing MIP turbine overhaul at Mainz, notes that this margin is allowed for in the tank's design performance, and calculations show that achieving 100% of rated power would in many cases double the overhaul costs.

The test cells are designed to receive the test piece and dynamometer as a palletized unit, and devised to allow rapid connection of control cables, fuel lines, coolant supply, and sensor cables. The dynamometer itself is connected into a closed loop fluid supply system, with the water recycled to the dynamometer after cooling in dedicated towers.

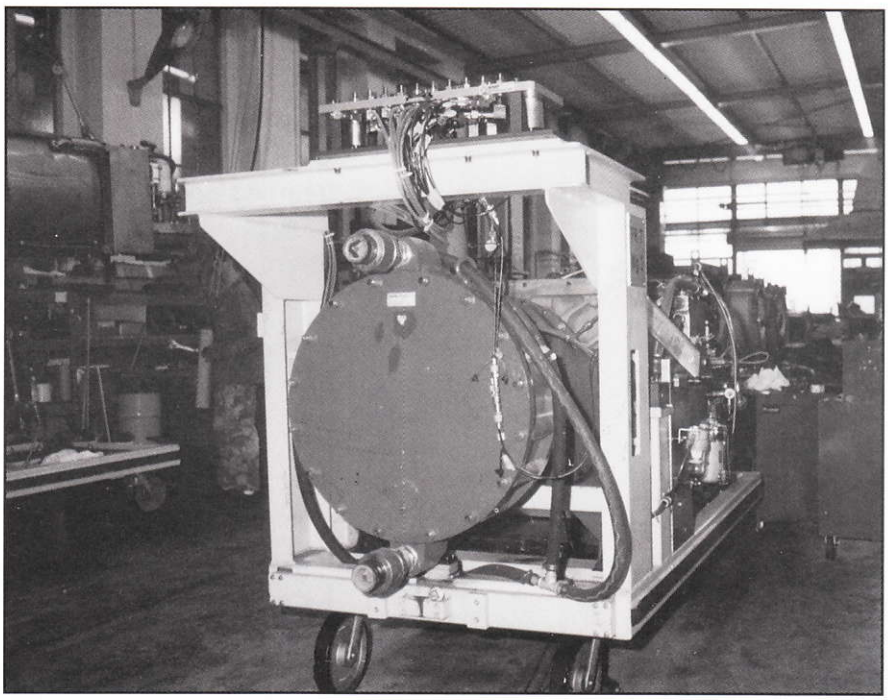
The Kahn model 102-240 portable dynamometers used in Mainz weigh only 400 kg and are designed to handle a maximum power output of 2235 kW at a maximum speed of 4500 r/min. The maximum torque rating is 5423 Nm.

Kahn's 102 series hydraulic dynamometers — with ratings from 1340 to 2235 kW — are built to meet the steady-state and transient test requirements of a variety of turboshaft and turboprop engines. The compact water brake dynamometers use hardened stainless steel power elements designed to resist cavitation and corrosion, and feature a low moment of inertia for quick transient response. The units can absorb full power in either direction of rotation, and use standard AND 10262 mounting flanges. The dynamometer shafts incorporate a built-in 60-tooth gear for use with magnetic speed pick-ups.

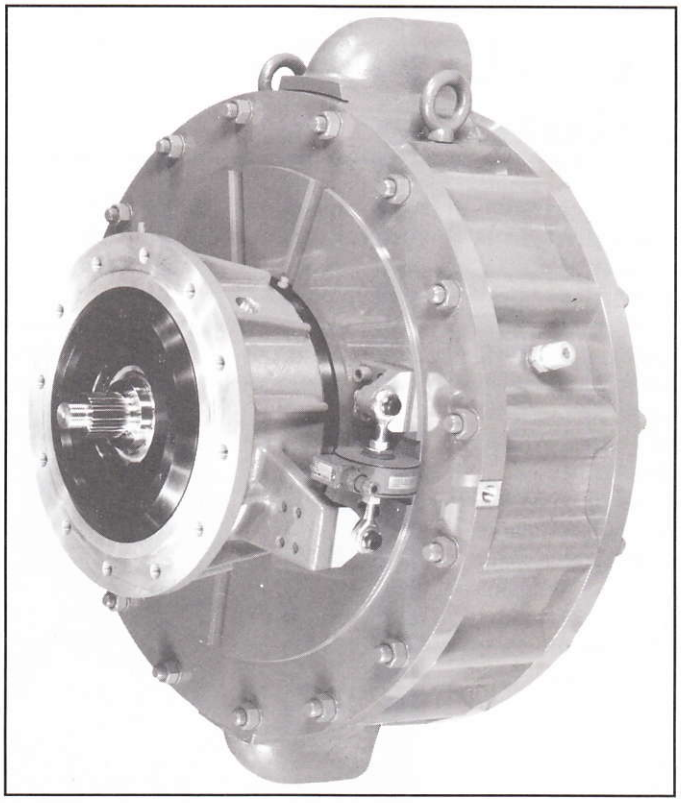
The flange-mounted design configuration of the 102-240 dynamometer permits alignment-free installation of the unit directly to the rear support bracket of the AGT1500 gas turbine. A floating, splined quillshaft transmits the power output from the turbine to the dynamometer. Direct mounting saves time-consuming drive shaft alignment procedures and significantly reduces the complexity of the test stand design, according to Kahn officials. For example, the company says, installing the AGT1500 gas turbine on the test stand can be done in less than 30 minutes, a procedure that requires at least three hours with a stationary, base-mounted dynamometer.

The modular design of the dynamometer makes servicing the unit easy. Also for easy service, the perforated stainless steel rotors are mounted to the shaft with a self-centering polygon connection, so no shrink fitting is required. This design also reduces bore stresses.

The entire test system at the Mainz Depot is maintained and serviced by TAP GmbH, Kerken, Germany, an engineering firm specializing in engine test cell design. ■



The M1 tank power module with dynamometer attached prior to testing.



The Kahn 102 series dynamometer.

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