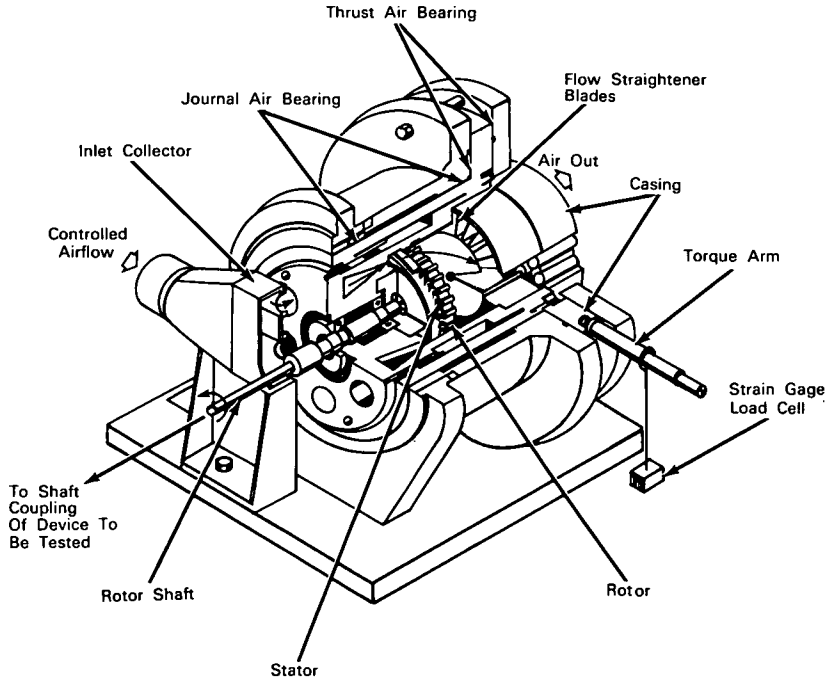
October 1965

Brief 65-10312

NASA TECH BRIEF

Air Brake-Dynamometer Accurately Measures Torque



The problem: To absorb and measure power outputs (up to about 20 hp) of rotating machinery over an extremely wide range of shaft speeds—from 0 to beyond 75,000 rpm. Conventional air brakes, which consist of fans or air screws coupled to the output shaft, have the disadvantage of absorbing power in proportion to rotational speed. At low shaft speeds, very little power can be absorbed. At high rotational speeds, conventional air screws cannot measure low torques.

The solution: An air brake-dynamometer assembly that operates on the combined principles of the air turbine and air pump to apply braking torque. The assembly consists of an inlet collector, a conventional turbine stator, a rotor with axial vanes, and flow straightener blades rigidly fastened to a displaceable casing to assure axial discharge of the air which in turn assures that the torque on the casing can be directly measured as the shaft output torque.

How it's done: The air brake-dynamometer assembly is mounted on air bearings designed to constrain the axial movement of the air brake-dynamometer and still offer very little frictional resistance to rotation.

In operation, the rotor shaft is coupled to the output shaft of the device to be tested. Ordinary shop air

(continued overleaf)

at a controllable rate of flow enters the inlet collector and is accelerated through the stator. The stator imparts a tangential momentum to the air in a direction opposite to the direction of rotation of the rotor. The rotor removes tangential momentum from the air and thereby absorbs the power from the tested device. After leaving the rotor, the air passes through a flow straightener where it is discharged from the system in an axial direction to make the torque on the casing equal to the torque on the rotor. The torque output is measured with a strain gage load cell attached to the casing through a 10-inch torque arm. Torques can be measured with an accuracy of ±0.1 pound-inch. Output power is easily computed from the torque and the shaft rotational speed, which is measured by any convenient method.

Notes:

1. Throttling the air into the air brake-dynamometer permits large variations on the power absorption capabilities over a wide range of shaft speeds.
2. This air brake-dynamometer is particularly well adapted to absorbing and accurately measuring extremely small power outputs of turbines operating at low inlet pressures. Other possible applications are the testing of electric motors and piston-driven engines.
3. Through two sets of oppositely oriented stator blades and a valving arrangement, the assembly can operate in a clockwise or counterclockwise direction. This arrangement also allows for almost zero power at any speed, because air directed through the appropriate stator can be used to reduce windage and bearing friction on the rotor.
4. The assembly can also be used as a straightforward air turbine or air motor, producing power over a wide range of speeds and torques in both clockwise and counterclockwise directions.
5. Further information concerning this invention is presented in NASA-TN-D-1315, "Air Performance Evaluation of a 4.0-Inch-Mean-Diameter Single-Stage Turbine at Various Inlet Pressures from 0.14 to 1.88 Atmospheres and Corresponding Reynolds Numbers from 2500 to 50,000," by Robert Y. Wong and William J. Nusbaum, August 1962, available from Clearinghouse for Federal Scientific and Technical Information, Springfield, Virginia, 22151. Inquiries may also be directed to:

   Technology Utilization Officer
   Lewis Research Center
   21000 Brookpark Road
   Cleveland, Ohio, 44135
   Reference: B65-10312

Patent status: NASA encourages the immediate commercial use of this invention. It is owned by NASA, and a patent application has been filed. When patented, royalty-free nonexclusive licenses for its commercial use will be available. Inquiries concerning license rights should be made to NASA, Code AGP, Washington, D.C., 20546.

Source: Lewis Research Center
(Lewis-163)