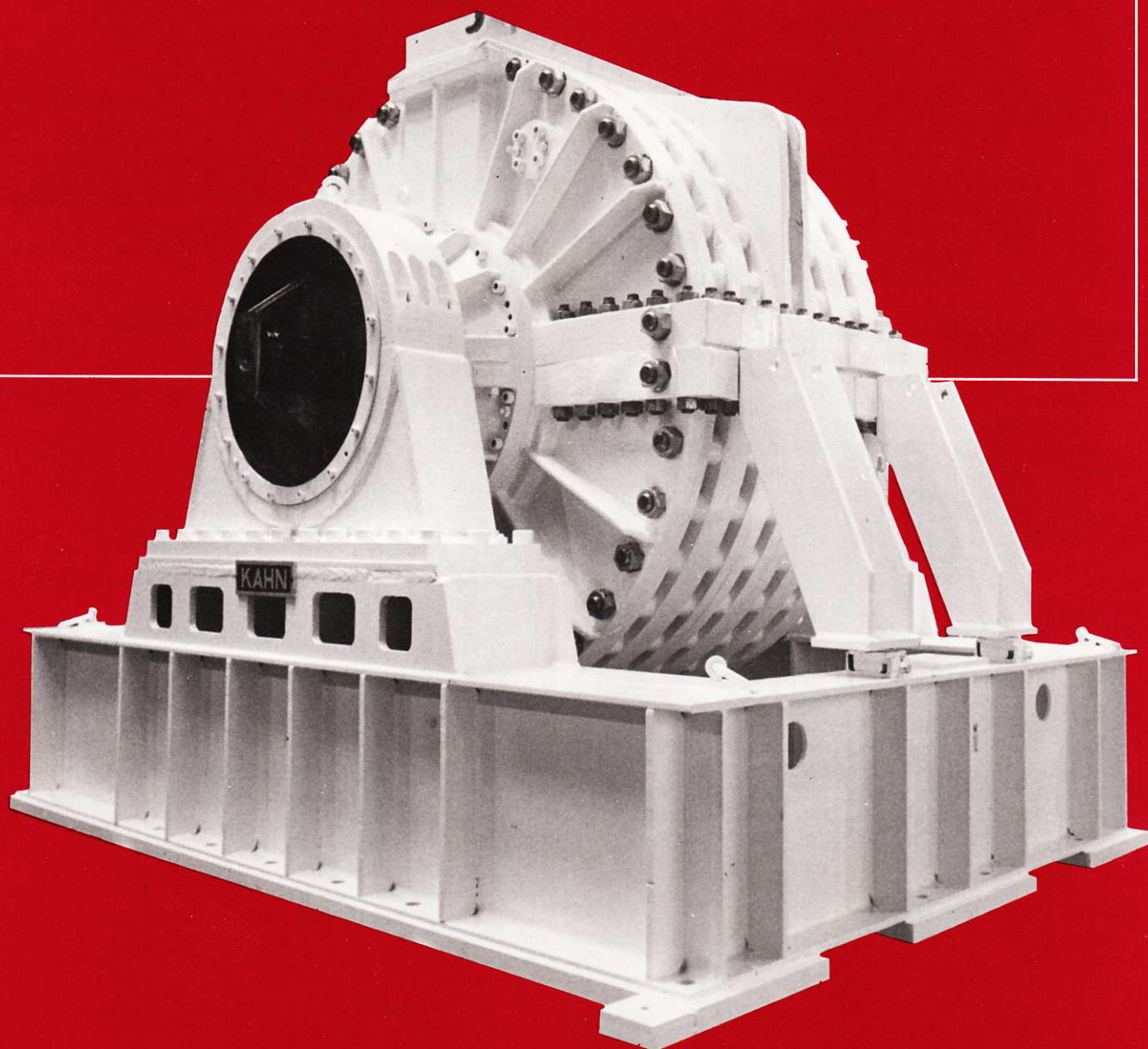


**CAVITATION-FREE  
HYDRAULIC  
DYNAMOMETERS  
FOR TESTING  
GAS TURBINES**

KAHN SERIES

**400**



**KAHN**  
KAHN INDUSTRIES INC.



# KAHN SERIES 400 HYDRAULIC DYNAMOMETERS FOR TESTING GAS AND STEAM TURBINES

Heavy, rugged, base mounted dynamometers designed for continuous high power, high speed operation. Inherently cavitation-free smooth disc power elements provide long service life with minimum maintenance requirements. Seven models with capacities ranging from 7000 hp (5200 kW) to 80,000 hp (60,000 kW) per unit.

## DESIGN FEATURES

- Smooth disc power elements guaranteed against cavitation
- High internal water pressure facilitates quick transient response
- Horizontally split housing permits quick installation and removal of rotor assembly
- Individual water supply to each rotor provides excellent operating stability
- Self-aligning pivoted shoe type journal and thrust bearings
- Non-contacting two stage labyrinth seals
- Water inlet through flexible o-ring joint permits hard piping connection
- All service lines terminated in bulkhead fittings on base
- Built-in water discharge valves
- Full power absorption in both directions of rotation

## OPERATING PRINCIPLE

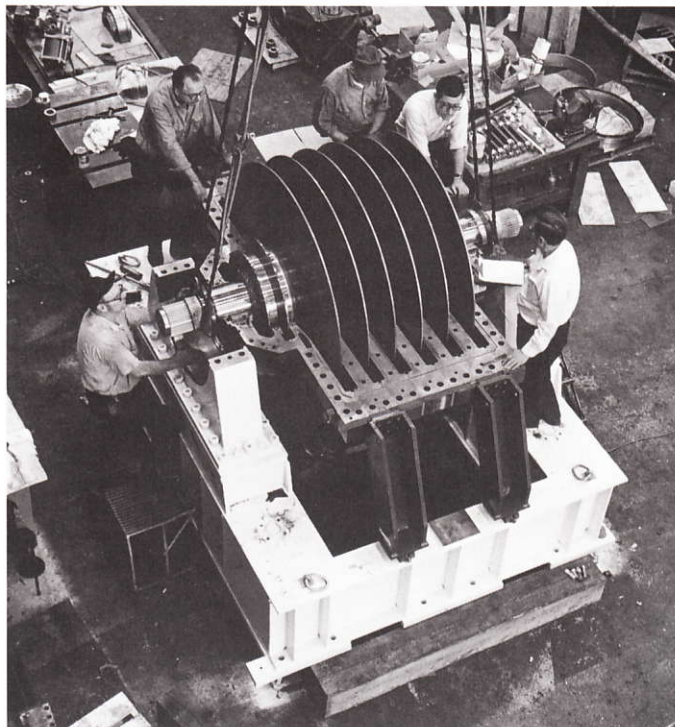
Several smooth discs rotate in a housing between smooth stators. Cold water enters each rotor chamber from both sides near the root diameter of the disc. The water is accelerated by the rotating disc and thrown outwards. From the outer diameter of the rotor chamber inwards, the water forms an annulus which rotates at approximately half of the angular disc speed. The centrifugal pressure resulting from this process, forces the water out of the rotor chambers.

Power is absorbed—and converted into heat—by viscous shear in the boundary layers adjacent to rotor and stator surfaces. The resulting drag applies resistance to rotation and tends, with an equal effort, to turn the dynamometer housing in the trunnion bearings. The housing is restrained from turning by a load cell, which is mounted to the torque arm at a fixed distance from the centerline of the dynamometer.

The amount of power absorbed by the dynamometer is a function of water level (size of rotating water annulus) and speed. The water level is modulated with the inlet and outlet control valves. At a given speed, maximum power is absorbed when the rotor chambers are completely filled with water.

## ROTOR ASSEMBLY

Six smooth tapered discs machined with an approximate uniform stress profile. Small rotors are made from a solid stainless steel forging. Large rotors consist of individual discs made from high strength alloy steel. The discs are clamped together with prestressed axial tiebolts. Torque is transmitted by surface friction between the discs. After final machining, the working surfaces of the discs are flame sprayed with a stainless steel coating to protect against corrosion. All rotating parts are subjected to an ultrasonic and a magnetic particle inspection. The entire rotor assembly is dynamically balanced to turbine standards.



**Model 406-160 dynamometer during assembly. The rotor assembly has a diameter of 63" (1600 mm) and weighs 15,250 lbs (6900 kg).**

## BEARINGS, LUBRICATION AND SEALS

Two self-aligning, pivoted shoe type journal bearings. Double acting, pivoted shoe type thrust bearing to carry unbalanced axial loads which may occur during transient operation. Lubrication requirements:

|                    |                               |
|--------------------|-------------------------------|
| Oil Type           | Light Turbine Oil*            |
| Oil Flow Rate      | Up to 140 gal/min (530 l/min) |
| Supply Pressure    | 20 psig (1.4 bar)             |
| Supply Temperature | 120°F (49°C)                  |
| Return Temperature | 150°F (66°C)                  |
| Filtration         | 25 micron                     |

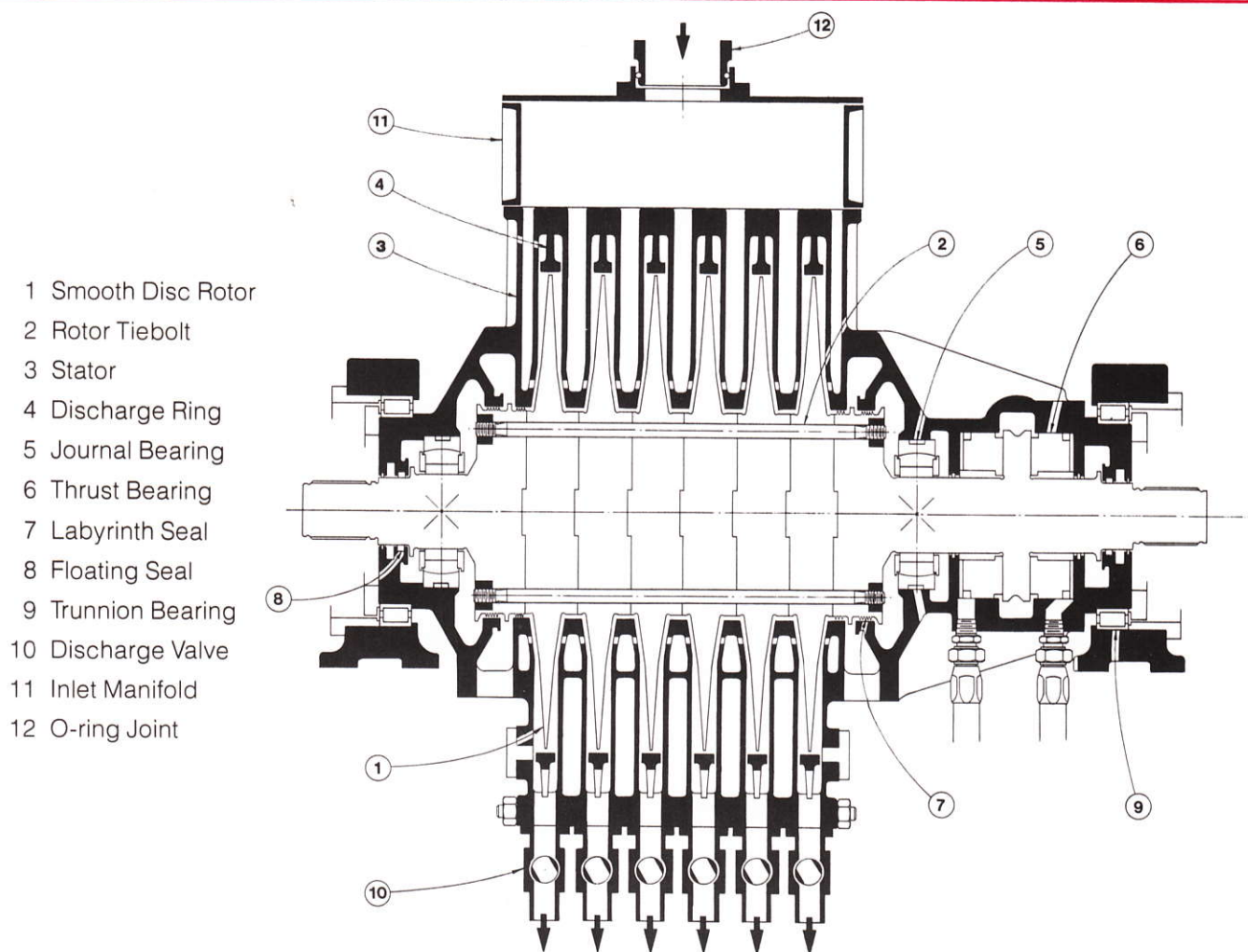
\*i.e. Mobil DTE light, petroleum based, viscosity 5.2 cSt at 210°F (99°C)

Non-contacting, two stage labyrinth seals between rotor chambers and bearings. Soft seal liners facilitate small radial design clearances and run-in of the seals during assembly. The shaft ends are sealed by oil lubricated floating seal rings.

## HOUSING ASSEMBLY AND BASE

Ductile cast iron stators, horizontally split to facilitate quick installation and removal of rotor. Stator working surfaces are flame sprayed with a stainless steel coating to protect against corrosion. Assembled with pre-stressed axial and vertical tiebolts. One-piece water discharge rings made from cavitation resistant nickel aluminum bronze. Removable inspection plugs in both end stators. Grease lubricated anti-friction trunnion bearings, cast iron trunnion mounts. Rigid base weldment made from structural steel. Torque arm with calibration extension, safety arm with restraining bracket mounted on opposite side of housing. Water inlet through flexible o-ring joint permits hard piping connection. Built-in water discharge valves with common actuator linkage—discharging directly into water drain. All service lines (oil supply, oil return, water/oil drain) are terminated in bulkhead fittings on the base.





## SPECIFICATIONS

| Model   | Max. Power<br>hp | Max. Speed<br>rpm | Max. Torque<br>ft. lb | Approx. Dry Weight<br>lbs |
|---------|------------------|-------------------|-----------------------|---------------------------|
| 406-040 | 7,000            | 18,000            | 3,050                 | 6,700                     |
| 406-050 | 10,000           | 14,000            | 5,500                 | 7,500                     |
| 406-065 | 16,000           | 11,000            | 11,500                | 13,000                    |
| 406-080 | 24,000           | 9,000             | 21,000                | 20,000                    |
| 406-100 | 35,000           | 7,500             | 37,000                | 32,000                    |
| 406-130 | 55,000           | 5,500             | 76,000                | 50,000                    |
| 406-160 | 80,000           | 4,500             | 140,000               | 80,000                    |

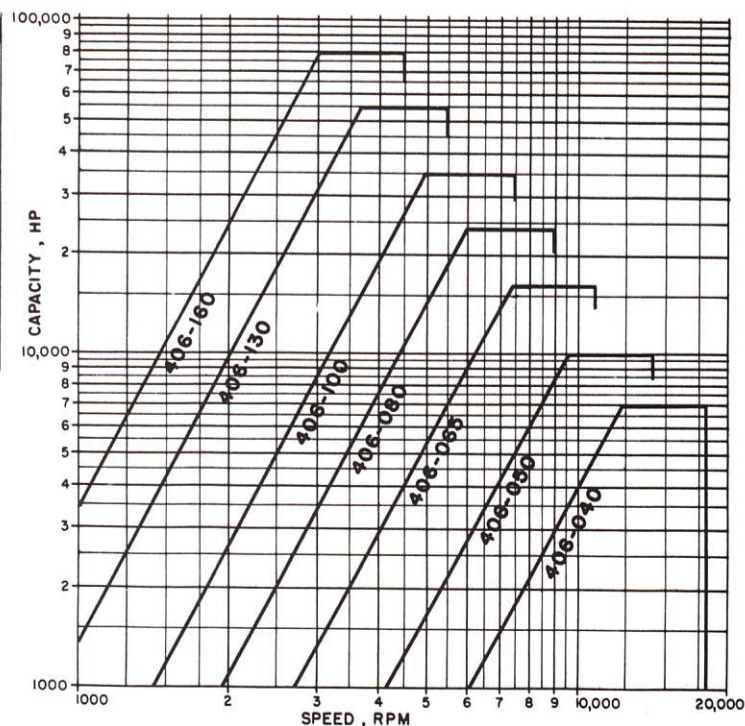
## WATER SUPPLY REQUIREMENTS

Hydraulic dynamometers convert mechanical energy into heat. A continuous flow of water through the dynamometer is necessary to provide resistance to rotation and to dissipate the heat. The flow rate is proportional to the amount of power absorbed.

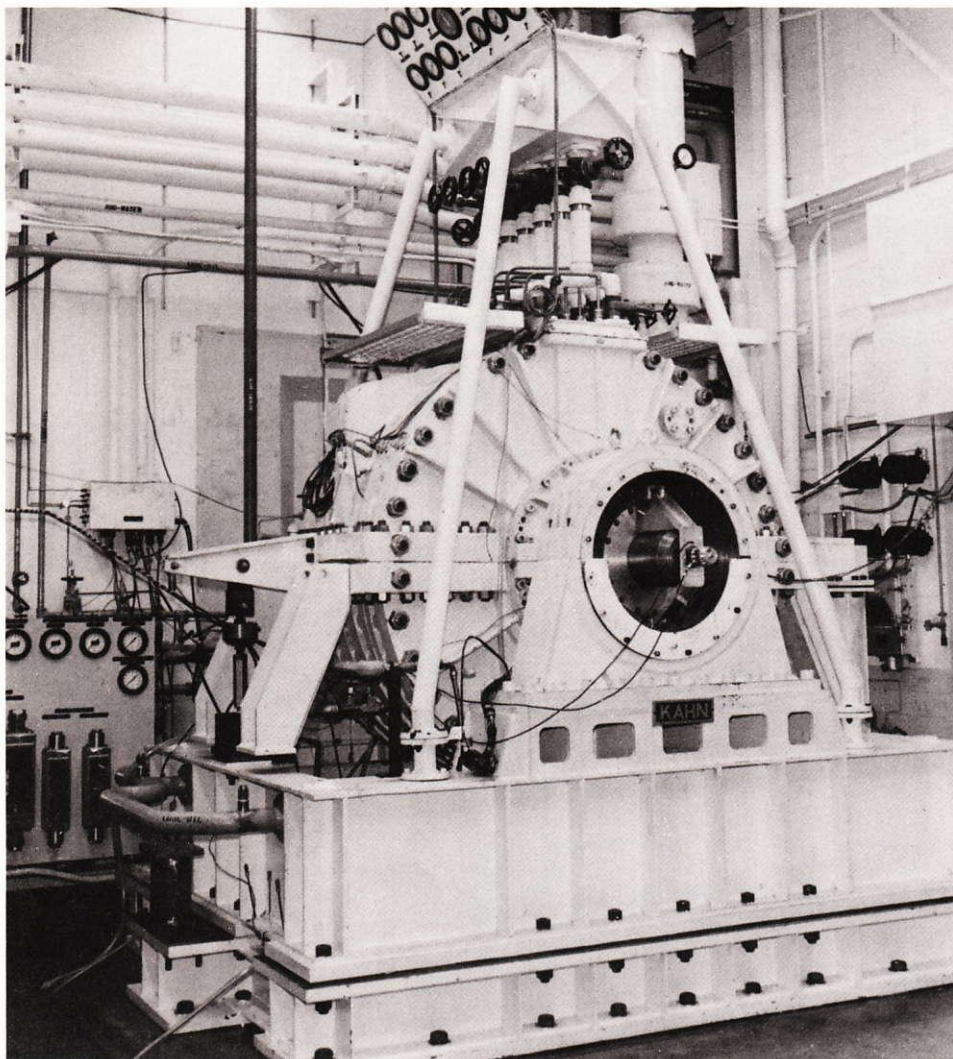
|                         |                          |
|-------------------------|--------------------------|
| Water Flow*             | 4 gal/hr hp (20 l/hr kW) |
| Supply Pressure         | 50 psig (3.5 bar)        |
| Max. Inlet Temperature  | 90°F (32°C)              |
| Max. Outlet Temperature | 180°F (82°C)             |
| Filtration              | 750 micron               |

\*at  $\Delta t = 76^\circ\text{F} (42^\circ\text{C})$

## OPERATING RANGE







*Model 406-160 hydraulic dynamometer as installed at General Electric's Evendale, Ohio plant. Used for endurance and production testing of the LM 2500 marine and industrial gas turbine. No evidence of cavitation after 5500 hours of operation.*

## **AUTOMATIC CONTROL SYSTEM SERIES 503**

State of the art electro-pneumatic feedback control system with three control mode options:

1. Speed control—when testing ungoverned turbines
2. Torque control—when testing governed turbines
3. Manual control—for remote positioning of control valve

Control cabinet containing modular instrument system with digital speed and torque indicators, 3-mode electronic controller (inlet valve), manual loading station (discharge valves), digital temperature indicator with 4-channel selector switch, pressure gages, vibration monitors, operational safeguards (alarm lights). Completely wired and tested.

Universal strain gage load cell (tension and compression), magnetic speed pickup, connecting cables 30 feet (9.1m) long. Electro-pneumatic control valves. Calibrated in english, metric or S.I. units. Capacity up to 50,000 hp (37,300 kW).

## **LUBRICATION SYSTEM SERIES 506**

Self contained, skid mounted oil system including oil reservoir, supply pump, scavenge pump, oil cooler and oil filter. Built-in alarm switches (low oil level, high oil return temperature, low oil supply pressure) plus local pressure, differential pressure and temperature gages. NEMA 12 electrical enclosure with pump motor starters. Completely wired and tested.

NOTE: The information included herein was correct at the time of publication and supersedes all previous data. It is our policy to continually improve our products to insure even better performance. Consequently, current Kahn products may incorporate modifications not shown on these pages.

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