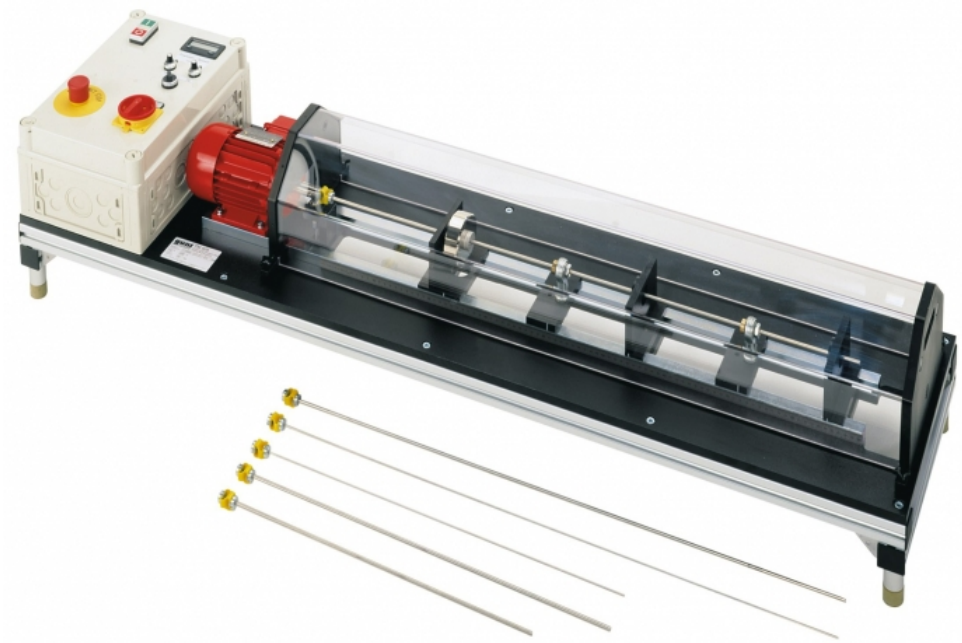
TM 625
Elastic shafts



Description

- **investigation of the natural modes of various shafts with continuous mass distribution and of a Laval rotor**
- **optimal visibility and simultaneous protection thanks to transparent protective cover**

The terms “critical speed” and “resonance” are often used when referring to rotating systems. Resonance occurs when the natural frequency and the excitation frequency match. The natural frequency of an oscillatory system is that frequency at which the system oscillates with the associated natural mode after a single excitation. Operation at critical speed can damage the system because of the high vibration amplitudes. In order to study the phenomenon of shaft vibration in more detail, there are two simplified calculation models. In the first case, the mass of the elastic shaft is evenly distributed along its length. In the second case, the shaft consists of massless, elastic shaft sections and the masses are combined into discrete mass disks.

The TM 625 experimental unit can be used to study the natural modes of these different models. Illustrative experiments are used to explain resonance and the supercritical or subcritical states of a vibrating system. Six shafts of different lengths and diameters are available. The shafts can be mounted on four self-aligning ball bearings and fitted with a mass disk to construct a Laval rotor. The axial positions are read on a scale mounted parallel to the shaft. A three-phase motor drives the shaft via a flexible coupling. The electronically controlled speed can be selected via two potentiometers and is continuously variable. It is displayed digitally.

A transparent protective cover and safety bearing ensure safe operation.

The measured values can be displayed and analysed on a PC using the optional TM 620.20 unit for data acquisition.

Learning objectives/experiments

- investigation of a Laval rotor
  - critical speed
  - self-alignment
- natural modes on a shaft with continuous mass distribution with
  - different bearing clearances
  - different shaft diameters
  - different shaft lengths

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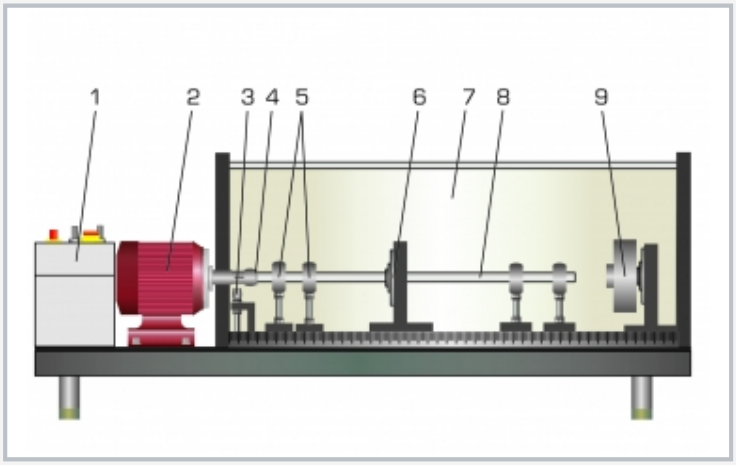
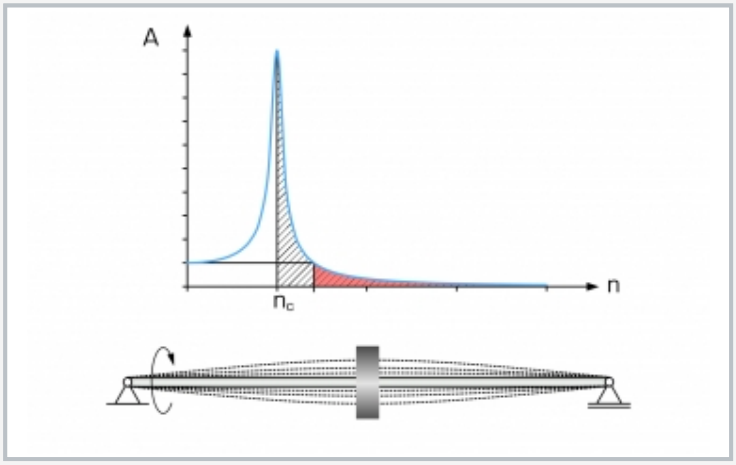
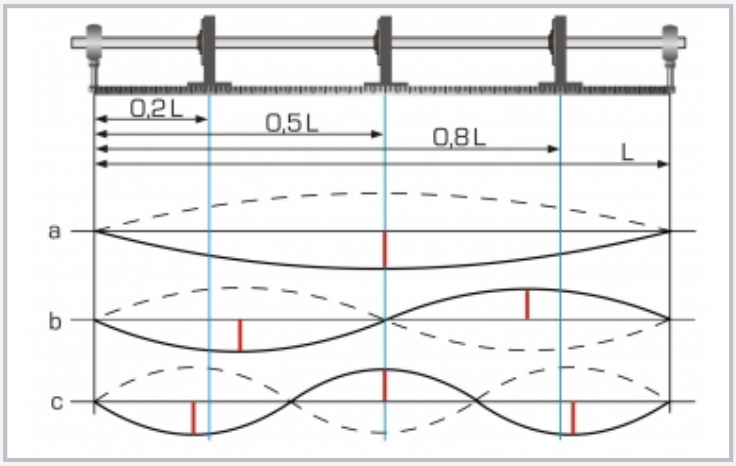


1 switch box, 2 motor, 3 inductive speed sensor, 4 elastic coupling, 5 self-aligning ball bearings, 6 safety bearing, 7 protective cover, 8 shaft, 9 mass disk



Vibration behaviour of a Laval rotor: n speed, A amplitude, n_c critical speed with resonance, shaded area: subcritical speed, red shaded area: supercritical speed with self-centring



Natural modes of a shaft with continuous mass distribution: a) first natural mode, b) second natural mode, c) third natural mode; red: amplitude of the vibration, blue: position of the safety bearing; L clearance of the shaft bearing

Specification

[1] experimental unit for determining critical speeds and investigating the natural modes of a shaft
[2] 6 high-tensile steel shafts
[3] up to 4 self-aligning ball bearings, each moveable to any point as a shaft bearing
[4] 1 mass for constructing a Laval rotor
[5] 3 safety bearings and transparent protective cover for safe operation
[6] three-phase motor: 2 pre-selectable speed ranges; speed electronically controlled and continuously adjustable
[7] digital speed display
[8] system TM 620.20 for data acquisition available as an option

Technical data

6 shafts
- Ø 3mm, 6mm, 7mm
- L: 600mm, 900mm
- high-tensile steel

Mass, disk-shaped
- Ø 80mm
- m: 965g
- high-tensile steel

Motor
- power: 0,25kW
- max. speed: 6000min^{-1}
- speed electronically controlled

Shaft bearing
- 4x self-aligning ball bearings
- 3x safety bearings

Measuring ranges
- speed: 0...6000min^{-1}
- scale for clearance measurement: 0...1000mm

230V, 50Hz, 1 phase
230V, 60Hz, 1 phase; 120V, 60Hz, 1 phase
UL/CSA optional
LxWxH: 1550x380x450mm
Weight: approx. 65kg

Scope of delivery

1 experimental unit
6 shafts
1 set of tools
1 set of instructional material

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Optional accessories

040.62020	TM 620.20	System for data acquisition
020.30009	WP 300.09	Laboratory trolley