Throwback Thursday - Rotating Machines

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Machinery protection and diagnostics topics
by
the engineering staff
of Bently Nevada

THE SELF-BALANCING CAPABILITY OF ROTATING MACHINES

Bently Nevada has a rich history of machinery condition monitoring experience and has always placed a high priority on educating and helping customers manage & maintain their equipment better. Every week, an article or Application Note that was published by Bently Nevada 'back in the day' will be highlighted. Although the format may be dated, the information is just as valid and informative as the original printing.

(Originally published in January 1987)

Most dynamic rotor malfunction mechanisms lack any sort of self-corrective capability. However, a rotating system will compensate for an out-of-balance situation by deflection at its bearings or by bowing its shaft to allow the rotor mass (including unbalance) to spin about the mass center. The latter will occur provided that rotative speed is well above the balance resonance speed for the existing mode of unbalance.

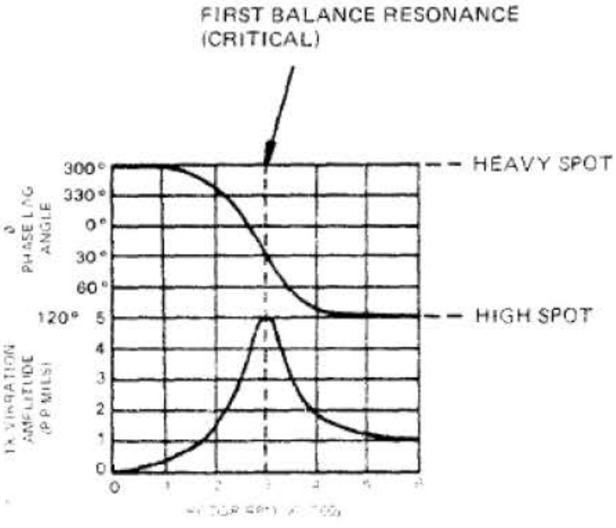
Self-balancing is an excellent characteristic of a rotating system, because even though each unbalance generates a rotating force that increases with the square of speed, the force transmitted to the bearing is small and essentially constant, and (independent of speed) is directly related to the amount of unbalance moment. In 1898, Delaval's discovery that a rotating body could indeed be operated in its self-balance mode resulted in a quantum jump in machinery development. Before that, the balance resonance speed region was considered "critical".

Naturally, this self-balance characteristic is not 100% effective for three basic reasons. First, if the unbalance is severe enough, the bearing orbital forces and the orbit size of the rotating bow are harmful or destructive to the machine, even when the rotor is correcting itself. Second, if a machine is operated between its translational and pivotal balance resonance rpm regions, and a net pivotal unbalance is incurred, no corrective pivotal action ensues. The unbalance action will even be amplified if the machine is run in the middle of the pivotal balance resonance region.

Finally, various types of mechanisms, mainly in the forward circular malfunction family but including some members of the forced resultive malfunction family, are excited by a balance resonance lying below rotative speed. Therefore, running above a self-balancing speed leaves the machine open to various groups of malfunctions. One of the major controls of these malfunctions is proper dynamic damping at operating conditions.

Prior to balancing a machine, Bode or Polar plots of its unbalance response should be constructed from vibration measurement data. The Bode plot, Figure 1, graphs rotative speed amplitude of motion or force vs. rpm and phase lag of high spots, compared to heavy spots as observed by a particular transducer at a specific location. The Polar plot, Figure 2, consists of the same data plotted
in polar form.

Using a set of synthetic "influence coefficients" may satisfy a simple balance job, but is no substitute for knowledge of accurately measured dynamic mechanical impedance response data.



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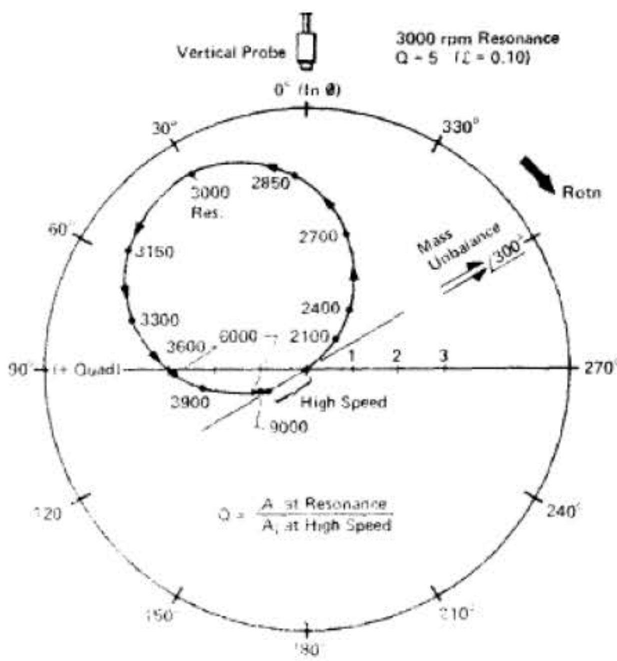

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