

If there is a Whistling Noise in the Bedroom...



What causes annoying noise in a hard disk drive and where does it come from? PM[°]DM, manufacturer of modern brushless spindle motors for data storage units, is pinning down the source of the noise with the aid of Laser Scanning Vibrometer technology.

Introduction

While once found exclusively in PCs, small hard disk drives (HDD) are now found in modern video recorders, DVD players, MP3 players and games consoles, serving as high performance data storage units. With their rapidly increasing presence in our everyday lives, the restrictions on HDD noise is also increasing continuously. In the future we will download movies we want to see from the internet overnight onto the hard disk of the digital video recorder at home, which may be in the bedroom. No one will accept a generally noisy or even continually whistling power unit while trying to sleep.

Background

Whistling noises from electric motors are caused by the excitation of individual components as vibration sources during operation. An effect of this kind occurs, for example, when a tram accelerates. At full speed the whistling noise is masked by the normal running noises and therefore is not noticed by the rider. However, it is quite a different matter for hard disk drives that are often located in quite areas. The newest generation of liquid-borne hard disks emit (virtually) no

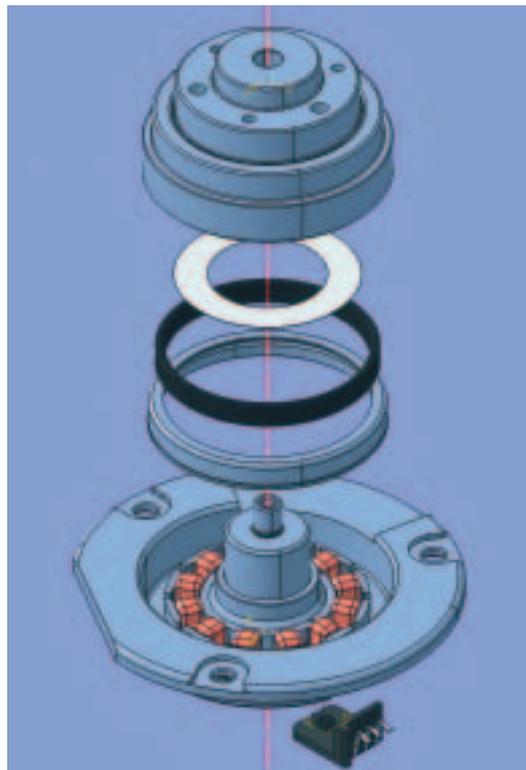


Figure 1: Design of a hard disk drive motor

audible noise during normal operation at 15,000 RPM. This means that any audible frequencies coming from the electromagnetic cycle of the motor stand out clearly in the spectrum and are perceived to be an annoying whistling noise (dominant tone).

Solution

The structure of the motor is depicted in Figure 1. It must be somewhere in the stator, in the winding or in the rotating magnet where the undesired noise is generated.

At PM^oDM the vibrations and the factors which affect them are examined with the aid of a glass-encased, universally adjustable spindle motor and the Polytec Scanning Vibrometer. The glass motor provides an unimpeded view of the stator at full speed at 15,000 RPM. Each component can be moved individually and independently of the others. The position of the stator with respect to that of the rotor can be shifted and tilted. These parameters are provided in the design of the motor, but are heavily influenced by production tolerances.

In the glass universal motor it is now possible for the first time to adjust all fitting positions directly. Component dimensions are also strategically changed. In every fitting position, the frequency, amplitude and deflection shape of the stator vibrations are measured with the PSV-300 Scanning Vibrometer (Figure 2).

In Figure 3, the defined measurement surface on the stator and the accompanying deflection shape in z-direction are shown.

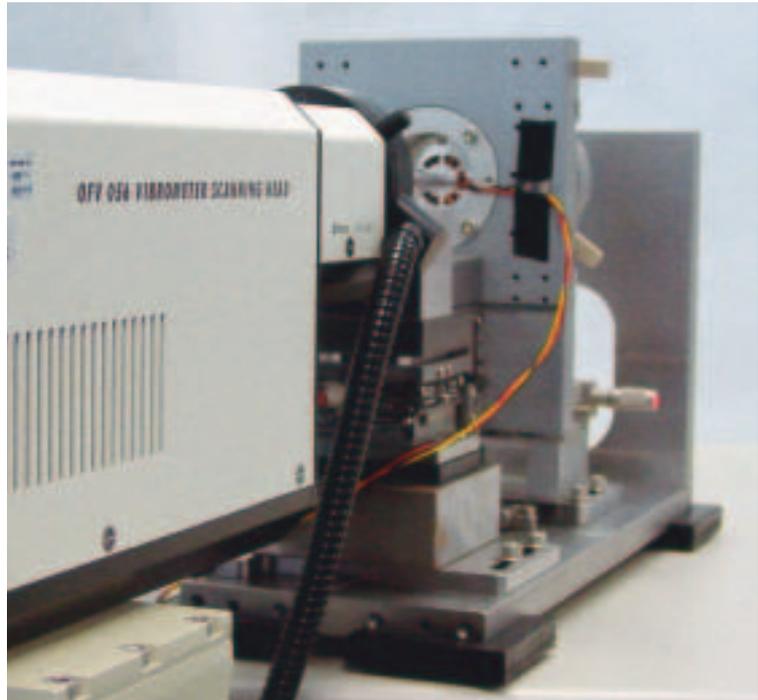


Figure 2: Measurement setup



Figure 3: PSV-300 display showing out-of-plane deflection of the stator

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About PM^oDM

PM^oDM develops brushless direct and alternating current motors for a broad range of applications, from the miniaturized computer hard disk to electrical steering aids in cars. The new research center for small electrical motors in the Minebea Group can be found in Villingen-Schwenningen in the Black Forest.

Summary

With the aid of scanning vibrometry, the sources of the dominant tones are found and identified with the vibration characteristics of individual components. To reduce the undesired noises, some component dimensions must be changed and optimized for minimal audible noise. The relative positioning of the components to each other is also important. If the optimization process reduces undesired tones below a minimum perception threshold then the consumer can finally download movies onto a digital video recorder without it disturbing his sleep.