November 2023

Damped Hard Drive Mounting

N/A

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ABSTRACT

Disclosed herein is a system for mounting a hard disk drive to a rack of a data center. A grommet is optimized for limiting the vibrational forces between the hard disk drive and the rack. Particularly, various grommet designs are optimized to limit the vibrational forces imparted on the rack such that neighboring hard disk drives are not affected by the vibrational forces emitted by neighboring hard disk drives, thereby increasing the lifespan of the grommets and hard disk drives and allowing the hard disk drives to be replaced quicker. The grommets are designed to have different stiffnesses and materials such that a user can select an appropriate grommet that corresponds to the hard disk drive implemented on a particular rack.

BACKGROUND

Hard disk drives (HDDs) include a rotating disk or platter that stores information written onto the disk. A read/write head uses electromagnetic induction to detect changes in the magnetic field of the disk while the disk is spinning. Because a motor is required to spin the disk, a rotational vibration energy is generated by the HDD. In systems that implement several HDDs, such as data centers and personal computers, the rotational vibration energy attributed to one HDD may be transmitted through the mounting rack to neighboring HDDs. Such a transmission of energy may degrade the HDDs within the system and cause off-track errors. As data centers expand and house more HDDs, a need for mounting and dampening individual HDDs at the rack level is desired, thereby enabling higher bit densities, tighter track spacing, and more rapid qualification of future HDDs.

DESCRIPTION

Hard Disk Drive Mounting

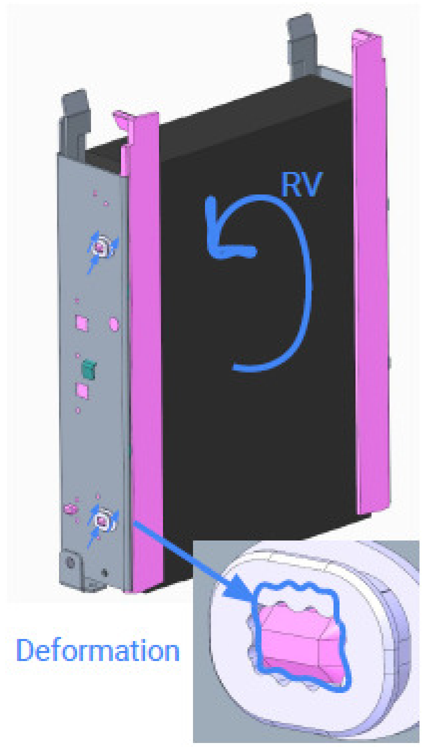

Figure 1 – Example Grommet Deformation on HDD

Figure 1 illustrates an HDD mounted to a rack of a data center. Traditional fasteners such as screws and bolts fail to provide sufficient vibration dampening for the mounting of HDDs without increasing the possibility of damaging neighboring HDDs through transferred rotational vibration energy. As such, grommets can be used in place of or in conjunction with traditional fasteners to provide increased dampening between HDDs and the trays and racks of a data center.

As illustrated in FIG. 1, two grommets are positioned through holes defined within a side rail of a data center rack. Although two grommets are illustrated, any number of grommets may be utilized. Grommets include a ring portion that is insertable within a hole that is configured to protect the hole and any internal structures extending through the hole, e.g., fasteners, wires, etc. The grommets may further include a pin portion that acts as a fastener to attach the HDD to the rack. Such a pin portion extends through the ring portion of the grommet and transfers energy from the HDD to the ring portion of the grommet.

Continuing with FIG. 1, two grommets are positioned in a vertical arrangement through holes in the rail of the rack. While the holes are illustrated in a vertical arrangement, they may also be positioned adjacent each other in a horizontal configuration, in a staggered configuration, or in other configurations. Additionally, any number of grommets may be utilized in any configuration. The illustrated grommets include a ring potion encompassing the holes of the rail and a pin portion extending through the ring portion. The pin portion may include a texture or design to aid in insertion of the pin portion. As such, the pin portion may include knurling to aid with insertion by hand or a design that mates with a distal end of a tool, such as a Phillips head, hex head, and the like. The pin portion may also include a shank extending from a head of the pin, and the shank may include threads, knurling, and other similar locking features. The shank may be configured to extend within a mounting hole of the HDD to secure the HDD to the rails of a data center rack. The pin portion may further include a locking feature at a distal tip, such as a barb or a cutting flute, to aid in engaging the HDD.

Grommet Ring Portion Designs

The ring portions of the disclosed grommets may have various designs to accommodate various frequencies exhibited by the HDD. Each of figures 2-4 illustrate a different ring portion design and will be described sequentially.

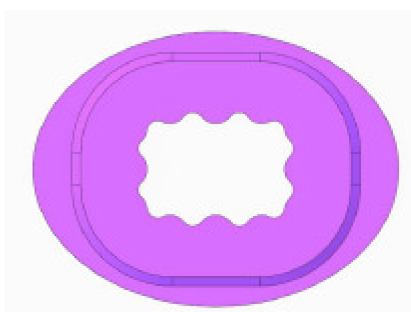

Figure 2 – First ring portion design

Figure 2 illustrates a first ring portion design. The first ring portion design defines a generally ovular outer perimeter, a generally ovular inner perimeter, and a central aperture. The outer perimeter may be ovular as depicted or another shape that corresponds to the shape of the corresponding hole of the rail. The outer perimeter is deformable and may be manipulated to extend through a hole and then expand to form a seal within the hole. The hole may be one of a variety of different shapes, such as a circular shape, an oval shape, etc. The central aperture defines a wave pattern having multiple peaks and valleys. When a pin portion is inserted through the central aperture, the peaks of the wave portion are configured to deform around the pin portion and form a seal around the perimeter of the pin portion. The wave pattern may be formed with a continuous wave design, such as a sine wave, or have irregular peaks and valleys to promote deformation in particular segments of the central aperture.

An inner perimeter is defined between the outer perimeter and the central aperture of the first ring portion. The inner perimeter defines an outer wall thickness between the inner and outer perimeters that is greater than an inner wall thickness between the central aperture and the inner perimeter. As such, the thinner inner wall may deform around the pin portion and absorb vibrational energy, which in turn prevents the vibrational energy from reaching the rack of the data center. The inner perimeter wall of the first design is smooth and lacks cutouts or other features formed in the wall such that the overall grommet is stiffer and requires a greater magnitude of force to deform.

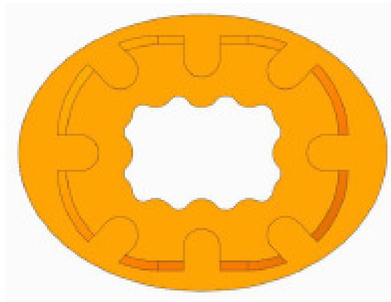

Figure 3 – Second ring portion design

Figure 3 illustrates a second ring portion design. The second ring portion design includes a generally ovular outer perimeter, a central aperture, and an inner perimeter defined between the outer perimeter and the central aperture. The primary difference between the first ring portion of Figure 2 and the second ring portion of Figure 2 is the shape of the inner perimeter wall. The inner perimeter wall of Figure 3 includes a waveform pattern similar to the waveform pattern of the central aperture. The waveform pattern of the inner perimeter wall includes various peaks and valleys formed into the thickness of the ring portion. Such peaks and valleys are formed through the inner perimeter wall such that each peak is positioned between two adjacent valleys. The size of the peaks and valleys is preferably uniform as depicted to provide uniform compression when the pin portion is inserted through the central aperture. Each peak has a semicircular portion extending approximately 180° across and each valley has an arc extending between adjacent valleys. The arc may extend at an angle that corresponds to an angle of a segment of the adjacent outer perimeter.

It is appreciated that the second ring portion design of Figure 3 is more pliable than the first ring portion design of Figure 1 due to the waveform pattern of the inner perimeter. Thus, the second ring portion design of Figure 3 may be selected for applications involving higher vibrational forces as the second ring portion can flex and absorb the vibrational forces better than the first ring portion, at the expense of the second ring portion decaying faster than the first ring portion.

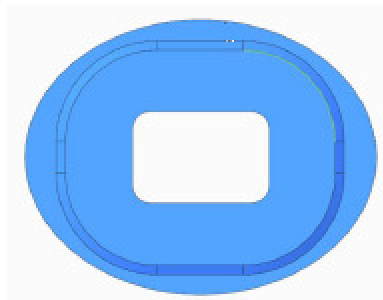

Figure 4 – Third ring portion design

Figure 4 illustrates a third ring portion design. The third ring portion design includes a generally ovular outer perimeter, a generally rectangular central aperture, and an inner perimeter defined therebetween. Unlike the central apertures of the first and second ring portions, the central aperture of the third ring portion is smooth and lacks a waveform pattern. The central aperture is generally rectangular as illustrated with rounded corners to aid in deformation of the central aperture over a pin portion.

It is appreciated that the third ring portion design of Figure 4 is stiffer than the first and second designs of Figures 2 and 3, respectively, and thus may be better suited for applications having lower vibrational frequencies. In turn, the third ring portion design of Figure 4 may have a longer lifespan than the first and second rings of Figures 2 and 3.

<u>Grommet Materials and Material Properties</u>

The grommets described herein can be formed from a variety of materials having various dampening properties. The ring portions may be formed from rubber, neoprene, various polymeric materials, and the like. The pin portion may be entirely metal, such as entirely steel or aluminum, may be metal and include a polymeric coating on top of the metal portions to aid in dampening qualities, or may be made entirely of a polymeric material. If the pin portion is entirely metal, it may be a standard screw, bolt, or other similar fastener.

A kit of grommets may be provided to a user, the kit including grommets of differing materials and geometries. A database may store various material properties of each grommet, the material properties including shear modulus, stiffness, compression modulus, area, shape factor, etc. A dampening frequency of each grommet may be calculated based on the relationship between the spring constant and mass of each material using the below formula. The resulting frequencies may then be stored in a database and selected by a user to correspond to a specific HDD application.

$$f_n = \frac{1}{2\pi}\sqrt{\frac{g}{\delta_{st}}}$$

Method of Use

The methods described herein involve grommets that secure and dampen HDDs within trays of a data center. It is appreciated that such methods may also be implemented in other applications that utilize hard drives, such as personal computers, gaming consoles, and the like.

An operator may first assess a data center and determine an appropriate location for positioning an HDD. Once a particular tray within the data center has been determined and an HDD is selected to fit the specific tray, a grommet may be selected that has vibrational frequency tolerances that correspond to the vibrational frequencies of the HDD. For example, if an HDD has a high vibrational frequency, a grommet having a high vibrational frequency tolerance may be selected based on the material and geometry of such a grommet.

Once a grommet has been selected, an operator may position the HDD within a tray of data center rack and align a mounting hole of the HDD with a mounting hole of a rail of the rack. A ring portion of the grommet may then be inserted within the mounting hole of the rail such that the ring portion encapsulates the mounting hole. A pin portion of the grommet is then inserted through a central aperture of the ring portion and through a corresponding mounting hole of the HDD to secure the HDD to the rack.

Implementing the grommet system and method described herein allows for individual HDDs to be mounted at the tray level to racks of a data center. Thus, as HDDs need to be replaced or upgraded over time, the pin portion of the grommets can be removed and individual HDDs can be removed from the rack and replaced, thereby decreasing the required maintenance time in which servers may be offline. Such a design is further advantageous over dampening systems that dampen multiple HDDs simultaneously, such as tray dampeners, which may fail to account for different vibrational energies emitted by different HDDs, and which may increase the maintenance time when a single HDD needs to be replaced.