SUMMARY OF THE INVENTION

It is an object of the present invention to ameliorate one or more disadvantages of the prior art.

According to one aspect of the present invention there is provided a magnetic disk drive for storing data comprising:

a drive motor including a shaft and a rotor rotationally mounted for movement relative to said shaft; a pair of ball bearing assemblies disposed intermediate said rotor and said shaft:

a magnetic disk disposed on said rotor for rotation with said rotor relative to said shaft;

a flange disposed on said rotor extending radially from said rotor and having a pair of planar faces;

a first ring spatially fixed with respect to said shaft and disposed juxtaposed with one of said pair of planar faces of said flange;

a second ring spatially fixed with respect to said shaft and disposed juxtaposed with the other of said pair of planar faces of said flange;

bearings, shaft and the hub of the disk drive are manufactured, some very limited movement of the rotor may occur about and/or along an X or Y axis and along the Z axis, where the axis of rotation and the Z axis are coincident and the X and Y axis are radial to the shaft. Depending upon the point of impact or shock, the most likely motion will be a rotation of the rotor may occur about either or both of the X and Y axes. This rotation of the hub and consequently the inner and outer races will compress at least one ball in each of the ball bearing assemblies. Depending on the amount of the rotational movement and the spacing of the bearings, the compression may exceed the elastic deformation limit of the material of the races.

Where the bearing assemblies are both placed at positions near one end of the rotor and consequently one end of the shaft, the potential for bearing damage is increased. This increased potential for damage is due to the lever arm through which the impact force may act, thereby increasing the force on the balls and races. The only viable approach to preventing any damage caused by shock or impact forces is to cushion the device to absorb some or all of the forces or to block transmission of the forces to the bearing assemblies.

said rings having a state of contraction in a direction perpendicular to said faces when influenced by an electrical potential and a de-energized state when not influenced by said electrical potential;

a source of said electrical potential connected to said rings;

an electrical switch intermediate said source and said rings to connect and disconnect said source and said rings;

whereby said flange is disengaged by said rings when said electrical potential is applied to said rings; and said flange is engaged by said rings when said source is disconnected.

According to another aspect of the present invention there is provided a disk drive for storing data comprising:

an electrical motor including a shaft and a rotor supporting at least one magnetic disk;

surrounding said shaft, a pair of ball bearing assemblies;

said rotor rotationally supported relative to said shaft by said pair of ball bearing assemblies;

said rotor comprising an interior cylindrical surface coaxial with said shaft; and

at least one ring for preventing damage to said pair of ball bearing assemblies by blocking movement, of said rotor relative to said shaft in a radial direction, of sufficient magnitude to force components of said pair of ball bearing assemblies into engagement sufficiently to cause permanent deformation and damage to said components, said at least one ring for preventing damage attached to one of said shaft and said rotor and having a cylindrical surface in confronting relation to the other one of said shaft and said rotor and spaced from said other one of said shaft and said rotor by a first distance less than the distance said rotor must move relatively toward said shaft to cause permanent deformation of said components within said pair of ball bearing assemblies;

whereby said rotor is prevented from being displaced relative to said shaft sufficiently to permanently deform any of said components of any of said pair of ball bearing assemblies;

wherein said at least one ring is disposed on said shaft, intermediate said pair of ball bearing assemblies, and said at least one ring further comprises a piezoelectric material which contracts when an electrical potential is applied to said at least one ring, thereby creating a gap of said first distance.

According to still another aspect of the present invention there is provided a disk drive for storing data comprising:

an electrical motor including a shaft and a rotor supporting at least one magnetic disk;

surrounding said shaft, a pair of ball bearing assemblies:

said rotor rotationally supported relative to said shaft by said pair of ball bearing assemblies;

said rotor comprising an interior cylindrical surface coaxial with said shaft; and

at least one ring for preventing damage to said pair of ball bearing assemblies by blocking movement, of said rotor relative to said shaft in a radial direction, of sufficient

magnitude to force components of said pair of ball bearing assemblies into engagement sufficiently to cause permanent deformation and damage to said components, said at least one ring for preventing damage attached to one of said shaft and said rotor and having a cylindrical surface in confronting relation to the other one of said shaft and said rotor and spaced from said other one of said shaft and said rotor by a distance less than the distance said rotor must move relatively toward said shaft to cause permanent deformation of said components within said pair of ball bearing assemblies;

whereby said rotor is prevented from being displaced relative to said shaft sufficiently to permanently deform any of said components of any of said pair of ball bearing assemblies;

wherein said at least one ring comprises a pair of rings, each of said rings respectively disposed adjacent one of said pair of ball bearing assemblies, said rings having a metal portion and a piezoelectric portion bonded together, said piezoelectric portion contracting under an electrical potential, whereby said rings release engagement

with said rotor when energized and engage said rotor when de-energized to prevent movement of said rotor relative to said shaft.

According to still another aspect of the present invention there is provided a shock damage prevention apparatus for preventing permanent deformation in components of ball bearing assemblies of a disk drive having a shaft and a rotor, said shaft and said rotor supported relative to each other by said ball bearing assemblies, said damage prevention apparatus comprising:

a ring for protecting said ball bearing assemblies from shock impacts, said ring disposed surrounding said shaft and having an outer surface complementary to an interior surface of said rotor, said ring having a radial width to form a gap between said ring and said interior surface of said rotor of a radial distance less than a distance said rotor must be displaced in the radial direction to effect permanent deformation of any portion of said ball bearing assemblies of said disk drive,

wherein said ring is disposed on said shaft and intermediate said ball bearing assemblies and said ring comprises a piezoelectric portion which contracts in response to an electrical potential, whereby said outer surface of said ring and said interior surface of said rotor are each disengaged from the other when said ring is contracted and engaged with the other when said ring is not contracted.

A more complete and detailed understanding of the invention may be had by reference to the drawings and the detailed description of the invention to follow.

Brief description of the Drawings

FIG. 1 illustrates a conventional spindle motor such as may be used in a disk drive.

FIG. 2 is an illustration of the spindle motor of FIG. 1 wherein crash stop rings have been provided to reduce shock damage.

FIG. 3 illustrates another arrangement of the crash stop rings within the spindle motor illustrated in FIG. 1.

FIG. 4 illustrates an embodiment having crash stop rings disposed adjacent to the ball bearing assemblies of a spindle motor wherein the crash stop rings may be electrically controlled to engage and to disengage the spindle motor rotor.

FIG. 5 illustrates a crash stop ring of the type found in the motor illustrated in FIG. 4.

FIG. 6 illustrates a piezoelectric crash stop ring utilized to clamp a flange on the spindle motor rotor.

Fig. 7 illustrates a disk drive which may utilize the crash

CLAIMS

1. A magnetic disk drive for storing data comprising:

a drive motor including a shaft and a rotor rotationally mounted for movement relative to said shaft; a pair of ball bearing assemblies disposed intermediate said rotor and said shaft:

a magnetic disk disposed on said rotor for rotation with said rotor relative to said shaft:

a flange disposed on said rotor extending radially from said rotor and having a pair of planar faces;

a first ring spatially fixed with respect to said shaft and disposed juxtaposed with one of said pair of planar faces of said flange;

a second ring spatially fixed with respect to said shaft and disposed juxtaposed with the other of said pair of planar faces of said flange;

said rings having a state of contraction in a direction perpendicular to said faces when influenced by an electrical potential and a de-energized state when not influenced by said electrical potential;

a source of said electrical potential connected to said rings:

an electrical switch intermediate said source and said rings to connect and disconnect said source and said rings;

whereby said flange is disengaged by said rings when said electrical potential is applied to said rings; and said flange is engaged by said rings when said source is disconnected.

2. The magnetic disk drive of claim 1 wherein said direction of contraction of said first ring and said direction of contraction of said second ring are opposing and directed away from said flange and wherein said first and second rings are disposed in their contracted state.

3. A disk drive for storing data comprising:

an electrical motor including a shaft and a rotor supporting at least one magnetic disk;

surrounding said shaft, a pair of ball bearing assemblies:

said rotor rotationally supported relative to said shaft by said pair of ball bearing assemblies;

said rotor comprising an interior cylindrical surface coaxial with said shaft: and

at least one ring for preventing damage to said pair of ball bearing assemblies by blocking movement, of said rotor relative to said shaft in a radial direction, of sufficient magnitude to force components of said pair of ball bearing assemblies into engagement sufficiently to cause permanent deformation and damage to said components, said at least one ring for preventing damage attached to one of said shaft and said rotor and having a cylindrical surface in confronting relation to the other one of said shaft and said rotor and spaced from said other one of said shaft and said rotor by a first distance less than the distance said rotor must move relatively toward said shaft to cause permanent deformation of said components within said pair of ball bearing assemblies;

whereby said rotor is prevented from being displaced relative to said shaft sufficiently to permanently deform any of said components of any of said pair of ball bearing assemblies:

wherein said at least one ring is disposed on said shaft, intermediate said pair of ball bearing assemblies, and said at least one ring further comprises a piezoelectric material which contracts when an electrical potential is applied to said at least one ring, thereby creating a gap of said first distance.

4. A disk drive for storing data comprising:

an electrical motor including a shaft and a rotor supporting at least one magnetic disk;

surrounding said shaft, a pair of ball bearing assemblies;

said rotor rotationally supported relative to said shaft by said pair of ball bearing assemblies;

said rotor comprising an interior cylindrical surface coaxial with said shaft; and

at least one ring for preventing damage to said pair of ball bearing assemblies by blocking movement, of said rotor relative to said shaft in a radial direction, of sufficient magnitude to force components of said pair of ball bearing assemblies into engagement sufficiently to cause permanent deformation and damage to said components, said at least one ring for preventing damage attached to one of said shaft and said rotor and having a cylindrical surface in confronting relation to the other one of said shaft and said rotor and spaced from said other one of said shaft and said rotor by a distance less than the distance said rotor must move relatively toward said shaft to cause permanent deformation of said components within said pair of ball bearing assemblies;

whereby said rotor is prevented from being displaced relative to said shaft sufficiently to permanently deform any of said components of any of said pair of ball bearing assemblies;

wherein said at least one ring comprises a pair of rings, each of said rings respectively disposed adjacent one of said pair of ball bearing assemblies, said rings having a metal portion and a piezoelectric portion bonded together, said piezoelectric portion contracting under an electrical potential, whereby said rings release engagement with said rotor when energized and engage said rotor when de-energized to prevent movement of said rotor relative to said shaft.

5. A shock damage prevention apparatus for preventing permanent deformation in components of ball bearing assemblies of a disk drive having a shaft and a rotor, said shaft and said rotor supported relative to each other by said ball bearing assemblies, said damage prevention apparatus comprising:

a ring for protecting said ball bearing assemblies from shock impacts, said ring disposed surrounding said shaft and having an outer surface complementary to an interior surface of said rotor, said ring having a radial width to form a gap between said ring and said interior surface of said rotor of a radial distance less than a distance said rotor must be displaced in the radial direction to effect permanent deformation of any portion of said ball bearing assemblies of said disk drive,

wherein said ring is disposed on said shaft and intermediate said ball bearing assemblies and said ring comprises a piezoelectric portion which contracts in response to an electrical potential, whereby said outer surface of said ring and said interior surface of said rotor are each disengaged from the other when said ring is contracted and engaged with the other when said ring is not contracted.