Hard Disk Reading Process

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Modern disk drives typically consist of Magnetoresistive (MR) or Giant Magnetoresistive (GMR) heads.

The read heads are the interface between the magnetic physical media on which the data is stored and the electronic components that make up the rest of the hard disk.

- Heads are energy converters: they transform electrical signals to magnetic signals, and magnetic signals back to electrical ones again
- The heads do the work of converting bits to magnetic pulses and storing them on the platters, and then reversing the process when the data needs to be read back.
- The read/write heads are essentially tiny electromagnet
How It Works

- Data is written to a disk
- The Actuator looks through a table of stored data locations to find the where the chosen data is located
- When the correct sectors pass beneath the head, the magnetic fields from the bits induce resistively changes in the sensitive MR or GMR materials located in the reading elements within the head.
Ferrite Heads: How they work

- Ferrite heads are classic electromagnets.
  - Applying a magnetic field to a coil will cause an electrical current to flow; this is used when reading back the previously written information.
MR & GMR Heads: How they work

- Newer MR and GMR heads don’t induce current on the coil to read back the information, they operate by magnetoresistance.

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  Magnetoresistance is happens when materials change their resistance when subjected to different magnetic fields.

Detailed structure diagram of a GMR head assembly
MR & GMR Heads: How they work Cont.

- As the head passes over the surface of the disk, the material changes resistance as the magnetic fields change corresponding to the stored patterns on the disk.

- A sensor is used to detect these changes in resistance, allowing the bits to be read.

- Because the MR head isn’t generating a current directly the way Ferrite head do, it is more sensitive to magnetic flux changes.
Inside a GMR Head

1. **Free Layer**: the sensing layer of nickel-iron allow, and is passes over the surface of the data bits to be read. It is free to rotate in response to the magnetic patterns on the disk.

2. **Spacer**: nonmagnetic layer

3. **Pinned Layer**: held in a fixed magnetic orientation by cobalt. This is possible because its attached to the exchange layer.

4. **Exchange layer**: Made from antiferromagnetic material and fixes the pinned layer’s magnetic orientation.
When the head passes over a magnetic fields of one polarity (i.e. “0”), the free layer has its electrons turned to be aligned with those of the pinned layer, creating a lower resistance.

When the head passes over a magnetic field of the opposite polarity (i.e. “1”), the electrons in the free layer rotate so they are not aligned with the pinned layer. This causes an increase in the resistance of the overall structure.
Demonstration

Areas for Improvement

- Magnetic Materials on the disk must be made finer so smaller bits can be written and still be read.
- Reading elements must be made more sensitive so they can read smaller bits.
References

http://www.pcguide.com/ref/hdd/op/heads/op.htm

www.wikipedia.com