How Floppy Disk Drives Work

by Gary Brown

If you have spent any time at all working with a computer, then chances are good that you have used a **floppy disk** at some point. The **floppy disk drive (FDD)** was the primary means of adding data to a computer until the CD-ROM drive became popular. In fact, FDDs have been an key component of most personal computers for more than 20 years.

Basically, a floppy disk drive reads and writes data to a small, circular piece of metal-coated plastic similar to audio cassette tape. In this edition of **How Stuff Works**, you will learn more about what is inside a floppy disk drive and how it works. You will also find out some cool facts about FDDs.

History of the Floppy Disk Drive

The floppy disk drive (**FDD**) was invented at IBM by Alan Shugart in 1967. The first floppy drives used an 8-inch disk (later called a "**diskette**" as it got smaller), which evolved into the 5.25-inch disk that was used on the first IBM Personal Computer in August 1981. The 5.25-inch disk held 360 kilobytes compared to the 1.44 megabyte capacity of today's 3.5-inch diskette.

The 5.25-inch disks were dubbed "**floppy**" because the diskette packaging was a very **flexible plastic envelope**, unlike the rigid case used to hold today's 3.5-inch diskettes.

By the mid-1980s, the improved designs of the read/write heads, along with improvements in the magnetic recording media, led to the less-flexible, 3.5-inch, 1.44-megabyte (MB) capacity FDD in use today. For a few years, computers had both FDD sizes (3.5-inch and 5.25-inch). But by the mid-1990s, the 5.25-inch version had fallen out of popularity, partly because the diskette's recording surface could easily become contaminated by fingerprints through the open access area.

Parts of a Floppy Disk Drive

The Disk

A floppy disk is a lot like a cassette tape:

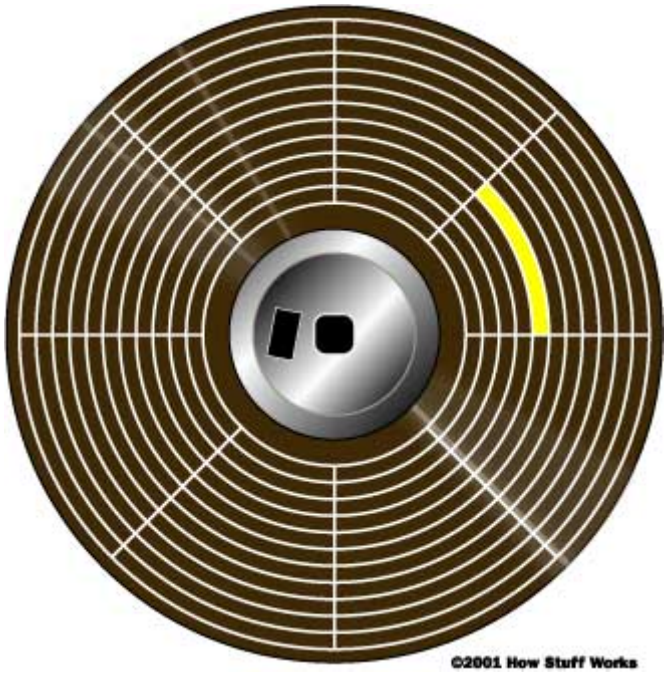
- Both use a thin plastic base material coated with iron oxide. This oxide is a **ferromagnetic** material, meaning that if you expose it to a magnetic field it is permanently magnetized by the field.
- Both can record information instantly.
- Both can be erased and reused many times.
- Both are very inexpensive and easy to use.

If you have ever used an audio cassette, you know that it has one big disadvantage -- it is a **sequential** device. The tape has a beginning and an end, and to move the tape to another song later in the sequence of songs on the tape you have to use the fast forward and rewind buttons to find the start of the song, since the tape heads are stationary. For a long audio cassette tape it can take a minute or two to rewind the whole tape, making it hard to find a song in the middle of the tape.

Floppy Disk Drive Terminology

- **Floppy disk** - Also called diskette. The common size is 3.5 inches.
- **Floppy disk drive** - The electromechanical device that reads and writes floppy disks.
- **Track** - Concentric ring of data on a side of a disk.
- **Sector** - A subset of a track, similar to wedge or a slice of pie.

are arranged in **concentric rings** so that the software can jump from "file 1" to "file 19" without having to fast forward through files 2-18. The diskette spins like a record and the heads move to the correct track, providing what is known as **direct access storage**.



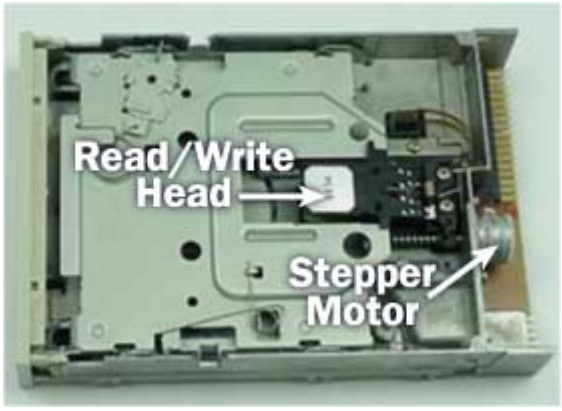
In the illustration above, you can see how the disk is divided into tracks (brown) and sectors (yellow).

The Drive

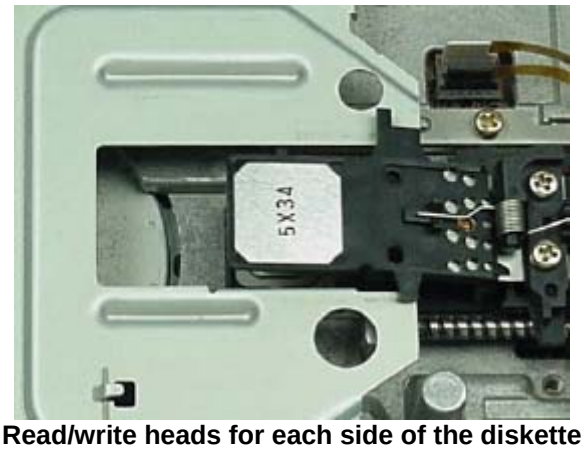
The major parts of a FDD include:

- **Read/Write Heads**: Located on both sides of a diskette, they move together on the same assembly. The heads are not directly opposite each other in an effort to prevent interaction between write operations on each of the two media surfaces. The same head is used for reading and writing, while a second, wider head is used for erasing a track just prior to it being written. This allows the data to be written on a wider "clean slate," without interfering with the analog data on an adjacent track.
- **Drive Motor**: A very small spindle motor engages the metal hub at the center of the diskette, spinning it at either 300 or 360 rotations per minute (RPM).
- **Stepper Motor**: This motor makes a precise number of stepped revolutions to move the read/write head assembly to the proper track position. The read/write head assembly is fastened to the stepper motor shaft.
- **Mechanical Frame**: A system of levers that opens the little protective window on the diskette to allow the read/write heads to touch the dual-sided diskette media. An external button allows the diskette to be ejected, at which point the spring-loaded protective window on the diskette closes.
- **Circuit Board**: Contains all of the electronics to handle the data read from or written to the diskette. It also controls the stepper-motor control circuits used to move the read/write heads to each track, as well as the movement of the read/write heads toward the diskette surface.

The read/write heads do not touch the diskette media when the heads are traveling between tracks. Electronic optics check for the presence of an opening in the lower corner of a 3.5-inch diskette (or a notch in the side of a 5.25-inch diskette) to see if the user wants to prevent data from being written on it.



Click on the picture to see a brief video of a diskette being inserted. Look for the silver, sliding door opening up and the read/write heads being lowered to the diskette surface.



Read/write heads for each side of the diskette

Writing Data on a Floppy Disk

The following is an overview of how a floppy disk drive writes data to a floppy disk. Reading data is very similar. Here's what happens:

1. The computer program passes an **instruction** to the computer hardware to write a data file on a floppy disk, which is very similar to a single platter in a hard disk drive except that it is spinning much slower, with far less capacity and slower access time.
2. The computer hardware and the floppy-disk-drive controller start the **motor** in the diskette drive to **spin the floppy disk**.

   The disk has many concentric tracks on each side. Each track is divided into smaller segments called sectors, like slices of a pie.

3. A second motor, called a **stepper motor**, **rotates a worm-gear shaft** (a miniature version of the worm gear in a bench-top vise) in minute increments that match the spacing between tracks.

   The time it takes to get to the correct track is called "access time." This stepping action (partial revolutions) of the stepper motor moves the read/write heads like the jaws of a bench-top vise. The floppy-disk-drive electronics know how many steps the motor has to turn to move the read/write heads to the correct track.

4. The **read/write heads stop at the track**. The read head **checks the prewritten address** on the formatted diskette to be sure it is using the correct side of the diskette and is at the proper track. This operation is very similar to the way a record player automatically goes

to a certain groove on a vinyl record.

5. Before the data from the program is written to the diskette, an **erase coil** (on the same read/write head assembly) is energized to "clear" a wide, "clean slate" sector prior to writing the sector data with the write head. The erased sector is wider than the written sector -- this way, no signals from sectors in adjacent tracks will interfere with the sector in the track being written.
6. The energized **write head puts data on the diskette** by magnetizing minute, iron, bar-magnet particles embedded in the diskette surface, very similar to the technology used in the mag stripe on the back of a credit card. The magnetized particles have their north and south poles oriented in such a way that their pattern may be detected and read on a subsequent read operation.
7. The **diskette stops spinning**. The floppy disk drive waits for the next command.

On a typical floppy disk drive, the small indicator light stays on during all of the above operations.

Floppy Disk Drive Facts

Here are some interesting things to note about FDDs:

- Two floppy disks do not get corrupted if they are stored together, due to the low level of magnetism in each one.
- In your PC, there is a twist in the FDD data-ribbon cable -- this twist tells the computer whether the drive is an A-drive or a B-drive.
- Like many household appliances, there are really no serviceable parts in today's FDDs. This is because the cost of a new drive is considerably less than the hourly rate typically charged to disassemble and repair a drive.
- If you wish to redisplay the data on a diskette drive after changing a diskette, you can simply tap the F5 key (in most Windows applications).
- In the corner of every 3.5-inch diskette, there is a small slider. If you uncover the hole by moving the slider, you have protected the data on the diskette from being written over or erased.
- Floppy disks, while rarely used to distribute software (as in the past), are still used in these applications:
    - in some Sony digital cameras
    - for software recovery after a system crash or a virus attack
    - when data from one computer is needed on a second computer and the two computers are not networked
    - in bootable diskettes used for updating the BIOS on a personal computer
    - in high-density form, used in the popular Zip drive