

How a Phonograph Cartridge Works

READING THE WRITTEN SOUND

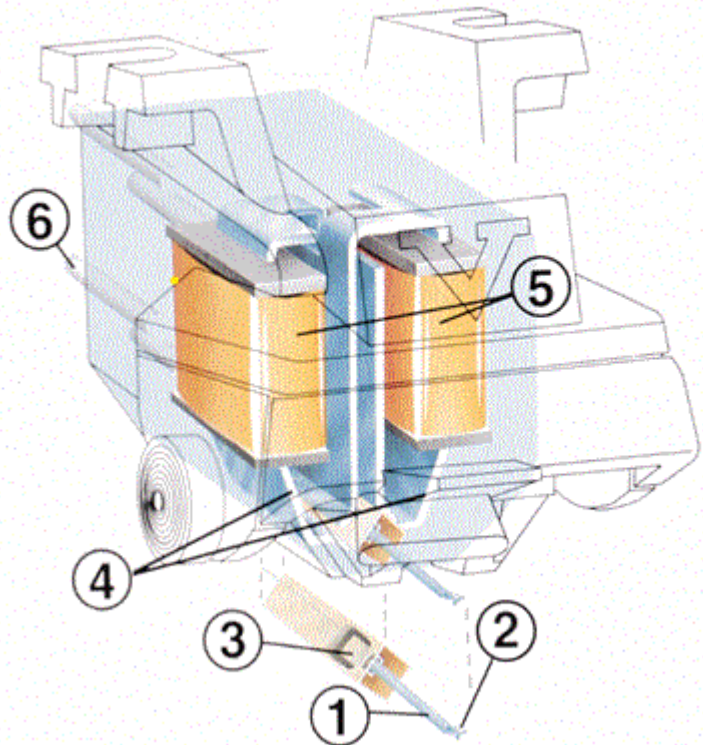
A phonograph cartridge is a micro-manufactured electro-mechanical device that tells your entire audio system what's happening along the half-mile groove that's cut into the typical analogue disc. The quality of the information provided by the cartridge is a critical determinant of how faithfully any audio system will reproduce the recorded sound.

CANTILEVERS & CARTRIDGE OPERATION

The **cantilever (1)** is a tube, or bar, with a **diamond stylus tip (2)** attached at one end, and a **magnet (3)** at the other (in the case of moving magnet cartridges). The cantilever must vibrate in exact sympathy with the rapid movements of the tip as it traces the audio signal, thereby moving the magnet attached at the other end.

Inside the cartridge body, magnetic con magnet. A **coil (5)** of pure copper wire wraps around the leg of each pole piece. As the magnet moves, its magnetic field is distributed between the conductors. Magnetic energy flows through the center of the copper coils and produces an electrical signal. This signal corresponds to the original motion of the tip, and is electrically transmitted to the amplifier through **terminal pins (6)** bonded to the ends of the coils. The amplifier, in turn, drives the speakers.

Because the cantilever is located at such a critical juncture in the signal chain, it has a dramatic effect on the quality of sound reproduction.



MASS

The lower the mass of the cantilever the better able it is to accurately duplicate the sound pattern written on the walls of the record groove. The lower the combined mass of the tip and cantilever (the stylus assembly), the less the chance that the tip will lose contact with the groove, and consequently, with the signal. The greater the stylus mass, the more likely it is that inertia will cause it to skip over signal information as it oscillates rapidly, tracing the signal pattern while the groove walls speed past. This is particularly critical in the high-frequency range, where audio modulations are the smallest and most concentrated, and stylus tip movement is consequently the most rapid.

TRACKING AND TRACKABILITY

Tracking is the term used to describe the positioning of the stylus tip in the spinning record groove. Tracking effectiveness is referred to as tracking ability, or trackability. The quantitative measure of trackability was first developed by Shure. It is defined as the maximum velocity at which the stylus tip can move back and forth tracing the audio signal before it starts to skip. This measurement is expressed in terms of centimeters per second. It should be observed at several different frequency levels, while tracking force is held constant.

A tracking failure is referred to as mistracking. Serious mistracking, when the high mass of the stylus causes it to veer out of control, can permanently damage a record by altering the signal patterns in the record groove. Such damage can occur in just one play.

STYLUS TIP

The stylus tip traces the musical signal inscribed in the record groove, which can contain modulations as small as a millionth of an inch. Tip geometry is a critical factor in determining the accuracy of sound reproduction. The narrower the side, or contact radius, of a biradial diamond tip, the more precise its ability to trace the audio signal. This is particularly critical in the complex, densely packed high-frequency range. The better a tip traces the audio signal, the more accurate the sound reproduction, and the more consistent this reproduction is across the audible spectrum. The term "detail" is often used when referring to the accuracy of signal tracing, as in "high detail," or "lacks detail."

FREQUENCY RESPONSE

The consistency of sound reproduction across the audible spectrum is generally described by the term frequency response, which is the range over which the cartridge sound output is essentially level, or "flat" - with fluctuations neither above nor below a reference level on a monitor. Because every manufacturer has its own definition of what the term "flat" means, with some dropping this qualifier altogether, the comparative value of posted frequency response ranges across brands is limited.

TRACKING FORCE

Tracking force refers to the total force holding the stylus in place in the record groove. Effective tip pressure on the record can actually be as high as several tons, due to the extremely small contact area between diamond tip and groove surface. The amount of tracking force is the major determinant of normal record wear (as distinguished from record damage, which is typically caused by mistracking.) The lower the tracking force, the lower the record wear, but also the lower the trackability. The best cartridges, such as Shure's V15VxMR, are able to achieve high trackability at a low tracking force.