

Thoughts on Turntable Design

by George Merrill

This paper covers the self generation and internal coupling of energy.

The turntable must cope with four types of energy:

One: Self generation and internal coupling of energy produced by the motor, drive system, platter support bearing and tonearm.

Two: Mechanically coupled energy that enters the support feet.

Three: Airborne energy contained within the operating environment.

Four: Energy generated by the stylus to groove contact during tracing (playing of the record).

The most important part of the design “Energy Management Design”

“Tonearm Release Energy” is the major determining factor of sonic performance.

This term “tonearm release energy” was coined during the development of the AR modifications (1976). Release energy is produced by the tracing of the record groove. The stylus only moves microns. A very small amount of energy intrusion will diminish low level information and cloud sonic quality. The start of the energy chain is within the cartridge body, this energy is equal and opposite of the stylus movement. The energy is then fed from the cartridge to the tonearm. Many cartridge and tonearm manufacturers now design their product with materials and form to minimize the body induced resonances produced by this energy. The final step is when the energy is released into the arm mounting platform. What happens at this step is the true test of the design. The energy must be dissipated and not reflecting back into the tonearm.

The Energy Management design principals are incorporated in the AR modifications and the Merrill Heirloom. In these designs the arm mounting platform is a non removable part of the subchassis allowing coupling the release energy to a large homogeneous dissipating area. This area was many times larger than that of any turntable produced at that point in time and probably most now. This is one of the main reasons for the sonic integrity and cult status of these old products.

Tonearm isolation

The second stage in the energy management design is to isolate the tonearm energy absorption area from any external intrusion of energy. This is challenging because the arm mounting system must be coupled rigidly to the platter system for reasons of stylus to record alignment. How well the tonearm mounting system is isolated from the platter assembly (platter, spindle and bearing) is critical to performance integrity. If isolation is not good an energy loop is set up between these parts and the design suffers to the degree of coupling. The amount of energy passed through this coupling loop can be verified easily with an electronic stethoscope.

The Merrill-Williams R.E.A.L. 101 solves this problem buy isolating and dissipating this energy within a 14 lb rubber elastomer.

The other major parts of the design

The Spindle Bearing

The design of a high quality spindle bearing is very simple. The lowest noise is achieved from an Oil Well design. (Test it with the stethoscope) The oil creates a dead quite isolation film between the shaft and the bearing. Belt tension load on a properly designed oil well turntable spindle bearing is of no consequence. A 7000 horse power dragster engine uses an oil film to separate the connecting rods from the crankshaft. This surface is about one inch wide, smaller in width than the length of a typical turntable bearing. The turntable bearing is placed under a few pounds of load.

The Drive System

The only drive system that will insure low noise intrusion uses a single elastic belt and a single isolated motor (The more motors or idler pulley bearings the more noise intrusion). A properly chosen belt as to the size, type, elasticity and free air length becomes a low pass filter. This filtering action helps eliminate higher frequency information from entering the platter and smoothes the motor impulses. Remember it only take a very small amount of energy to cloud the input from the stylus to the cartridge signal generator.

A synchronous motor (synchronous motors are frequency locked not feedback locked) of just enough torque (small motors equal low noise- large motors add more noise) is my choice. Some say much torque is necessary to overcome groove loading. Groove loading will to a very minuscule degree reduce the speed. Most any quality turntable with a heavy platter will have enough inertia to keep the micro speed changed invoked by signal modulation groove loading to a level completely undetectable.

The direct drive motor: The name indicates the absence of isolation from the motor to the platter. Direct drive turntable motors can exhibit cogging the amount of this cogging is determined by the pole number and the inertia (weight) of the platter. Hunting can be a problem if the feedback servo is lacking in definition.

Direct drive motors do not use an oil well bearing.

The rim drive (idler) is plagued with problems. The reason it came into existence is; in the past motors with torque enough to rotate the platter were of the induction type and operated at high speed (1800 rpm). The Idler drive allowed enough speed reduction (16-33-45-78 rpm platter speed) and made for a compact design. More bearings and a hard drive wheel that generates and transmits noise is a real detriment to sound quality. Some early turntable manufactures added a belt to the equation to tame the motor noise presented to the platter. But this did not eliminate the rolling wheel and second shaft bearing noise.

The test to verify if motor generated noise plays a roll is simple. I use a synchronous motor belt drive turntable. It is first powered directly by the AC supply line. After listening I substitute the direct AC supply line with a motor drive supply that generates an internal sign wave, thus isolating the motor from the AC line noise. The difference is striking, because eliminating any type of noise transmitted from the motor through the belt then into the record support platter always improves the sound.