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Howdy!

In this "Tech Tips" newsletter I hope to provide you with some interesting and perhaps helpful information about the types of permanent magnets used in pickups for guitar, bass and other amplified stringed instruments.

First a little review of how magnetic pickups work and a brief history of permanent magnets.

In a passive magnetic pickup the magnet(s) and the pickup coil work together to generate the electrical signal which is the output of the pickup. The magnetic field of the permanent magnet extends out into space and if there is a guitar string which contains iron or nickel within about ¼" of the top of the magnet, the invisible magnetic field will be caused to fluctuate at the same frequency as the vibrating guitar string. This fluctuating magnetic field causes electrons in the pickup coil windings to oscillate back and forth along the length of the coil windings thus generating the alternating current (AC) electric signal which ends up at the amplifier. This AC current is magnified by the large number of turns of wire on typical passive magnetic pickups (4,000 to over 10,000). As stated earlier, the magnetic field lines are invisible, and they also pass through many non-metallic materials such as paper, Forbon (vintage fiber material used in the construction of pickup bobbins) and plastic as if these materials were not there at all. The magnetic field strength drops off very rapidly with increasing distance from the magnet(s) as described in a recent Tech Tips newsletter.

A Brief history of magnetic materials as it pertains to pickups:

### **1917 - Cobalt Steel Magnets**

K. Honda and T. Takai add cobalt to tungsten steel to dramatically increase the coercive force of permanent magnets.

### **1919 - Commercial Steel Magnets**

The first commercially available quench-hardened steel magnets were produced.

### **1930 - Alnico Magnets**

I. Mishima produces the first Alnico magnet containing an alloy of iron, nickel, and aluminum.

### **1952 - Ceramic Magnets**

J.J. Went, G.W. Rathenau, E.W. Gorter, and G.W. Van Oosterhout from the Phillips Company develop the first commercial ceramic magnets based on barium, strontium, and lead-iron oxides.

### **1966 - Rare-Earth Magnets**

Dr. Karl J. Strnat at the U.S. Air Force Materials Laboratory at Wright-Patterson Air Force Base discovers the high magnetic field Samarium-Cobalt (SmCo<sub>5</sub>) alloy.

### **1972 - Advanced Rare-Earth Magnets**

Dr. Karl J. Strnat and Dr. Alden Ray develop a higher magnetic strength Samarium-Cobalt (Sm<sub>2</sub>Co<sub>17</sub>) alloy.

### **1983 - Neodymium-Iron-Boron Magnets**

General Motors, Sumitomo Special Metals and the Chinese Academy of Sciences develop a high magnetic field strength Neodymium-Iron-Boron (Nd<sub>2</sub>Fe<sub>14</sub>B) alloy.

Magnet types commonly used in modern pickups include: AlNiCo-II, AlNiCo-III, AlNiCo-V, ceramic magnet types, neodymium magnet alloys (sometimes referred to as “Neo” magnets) and samarium-cobalt alloys.

The qualities of permanent magnets which influence the tone and volume of pickups are: the magnetic field strength, the shape of the magnetic field, the location of the magnetic field lines with respect to the pickup coil and the inductive effect of the magnetic material on the coil.

Other pickup design features being equal, magnets with lower field strength (AlNiCo-II, for example) tend to generate a lower output signal with a warm tone and soft attack on the notes. Stronger magnets, such as AlNiCo-V tend to deliver high output signal, a bright tone and sharp attack.

Another interesting feature is the effect on the inductance of the pickup caused by the magnetic material. This inductive effect is most pronounced in pickups where the magnets are located inside the coil windings and is less strong in pickups in which the magnets are located under the coil. The presence of metallic magnets (all of the AlNiCo alloys and the rare earth magnets) will change the inductance of a pickup coil. Non-metallic magnets such as the ceramic variety do not change the inductance of a pickup coil.

One might think that stronger magnets would make for better pickups; but there is a limit to this notion. Very strong magnets (typically the rare earth magnets and ceramic magnets) exert a strong pull on the strings of the instrument and can reduce sustain.

Magnets and iron pole pieces (which serve to conduct the magnetic fields of the permanent magnets) are used in pickups in several configurations, each of which has a strong influence on the tone and output of the pickup.

In most strat style single coil pickups the coil windings surround a vertical array of AlNiCo rod magnets. The result is a bright, focused and often “bell like” tone with moderate output. The inductance of the pickup coil is affected by the AlNiCo alloy rods inside the pickup coil.

Some import strat style single coils feature ceramic bar magnets located under the pickup coil and a vertical array of six nickel plated mild steel pole pieces. Pickups of this design tend to have a bright tone with moderate output and are less likely to give the “bell tone” of a strat style pickup with AlNiCo rod magnets. The ceramic bar magnets do not change the inductance of the pickup coil.

P-90 style single coils often have two bar magnets located under the pickup coil; the adjustable height pole pieces (made from mild steel and often plated with nickel) serve to conduct the magnetic field of the bar magnets up through the center of the pickup coil and allow this field to return to the opposite end of the bar magnets after passing through the coil windings. The adjustable height pole pieces allow the owner of the

pickup to raise or lower the poles to achieve good volume balance from string to string. The tone of P-90 style pickups is often described as “aggressive” or “raunchy” with moderate to high output which can overdrive an amplifier.

Blade style single coil pickups can use a vertically bar magnet inside the pickup coil or use a mild steel pole piece located in the coil and in contact with bar magnets located under the coil. Blade style pickups often have a smooth, fat, warm tone well suited for jazz. The output of blade style pickups can vary, but many of these pickups - are low to moderate in output.

Humbuckers with side by side coils which often feature at least one coil with adjustable height pole pieces typically have a bar magnet placed horizontally under the coils and in contact with the pole pieces of the two coils. Pickups of this design have a wider magnetic field than single coil pickup. This wider magnetic field senses the vibration of an instrument’s strings along a longer section of the string (in the direction from the bridge to the nut). This accounts in part for the often fatter, less focused tone of a humbucker compared to a single coil pickup. Metallic bar magnets in a HB pickup can affect the inductance of the coils. A ceramic bar magnet will not affect the inductance of the coils and often results in a brighter tone.

Many of the pickups offered by Vintage Vibe Guitars are designed to allow the owner to change the magnets to dial in a preferred tone and output. In all of these designs the magnet type can be changed easily and the magnetic orientation of the pickup can also be reversed if desired. Changing the magnetic orientation of a pickup can be helpful in matching a new pickup to an existing pickup to achieve a reverse-wound, reverse polarity (RWRP) set of pickups.

Examples of these pickups are:

**SP-90 single coil:** strat size single coil design with adjustable height pole pieces and twin bar magnets located under the coil.

**T-90 single coil:** single coil pickups designed for tele style instruments. The T-90 pickups feature adjustable height pole pieces and twin bar magnets located under the coil.

**HS-90 SW single coil:** HB size single coil design with adjustable height pole pieces and twin bar magnets located under the coil.

**JZ-90 single coil:** single coil pickups designed for Jazzmaster style instruments. The JZ-90 pickups feature adjustable height pole pieces and twin bar magnets located under the coil.

**Soapbar-SW and Dogear-SW:** P-90 style single coil pickups which pickups feature adjustable height pole pieces and twin bar magnets located under the coil.

**HCC single coil:** blade style single coil pickup with a fixed position blade pole piece and twin bar magnets located under the coil.

**JG-90 single coil:** single coil pickups designed for Jaguar style instruments. The JG-90 pickups feature adjustable height pole pieces and twin bar magnets located under the coil.

**H540-SW humbuckers:** side by side PAF style humbucking design pickup with a bar magnet located under the coils.

**Vibetron humbuckers:** side by side vintage style humbucking pickups with 12 oversized adjustable pole pieces. The Vibetron pickups feature a bar magnet located under the coils.

### **New pickup designs with adjustable height rod magnets:**

**S-AR single coil:** strat size single coil design with adjustable rod magnets. Each of the six magnets can be independently adjusted for height and can also be removed and replaced. S-AR pickups can be configured with "mixed" magnet sets. An example of a mixed magnet set would be: AlNiCo-V magnets for the E and A strings, AlNiCo-III magnets for the D string and AlNiCo-II magnets for the G, B and e strings.

**Soapbar-AR and Dogear-AR:** P-90 style single coil pickups which feature adjustable height AlNiCo rod magnets. Each of the magnets can be independently adjusted for height and can also be removed and replaced. The HS-AR pickups can be configured with a mixed set of magnets.

**HS-AR:** Humbucker size single coil pickups which feature adjustable height AlNiCo rod magnets. Independent adjustment of the magnets is possible with this design as is removal and exchange of the magnets. The HS-AR pickups can be configured with a mixed set of magnets.

**Mini SC-AR:** Mini humbucker size single coil pickups which feature adjustable height AlNiCo rod magnets. Each of the magnets can be independently adjusted for height and can also be removed and replaced. The Mini SC-AR pickups can be configured with a mixed set of magnets.

**JB-AR:** Jazz Bass size single coil pickups which feature adjustable height AlNiCo rod magnets. Each of the magnets can be independently adjusted for height and can also be removed and replaced. The JB-AR pickups can be configured with a mixed set of magnets.

**PB-AR:** Precision Bass size split coil humbucking pickups which feature adjustable height AlNiCo rod magnets. Each of the magnets can be independently adjusted for height and can also be removed and replaced. The PB-AR pickups can be configured with a mixed set of magnets.

**More –AR pickup designs are in the works.**

I hope this information is helpful to you.

Best Wishes.

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