

The Speakers for Electric Guitar

Possibly the most crucial
– and less recognized –
factor for your tone.



*What makes them so special and so important? The perspective from **Jensen specialist Ignazio Vagnone***

Few categories of musicians may be as obsessed about their gear as much as the electric guitarist, and, as one myself, I'd dare to say, with very good reasons. Being comfortable with our tone is an essential element of the joy of playing our guitars, effects, and amps. A good tone makes us play better, feel better, and have more fun. But the wrong tone can destroy the experience, frustrate our efforts and ultimately make us put the guitar back in its case. Still, many among us rarely consider the relevance of the speakers in our amplifiers, leaving in a grey area this little-known component that instead could transform the tone of our rig.

TEXT: **IGNAZIO VAGNONE** PHOTOS: **JENSEN, ULFBASTEL (CC)**

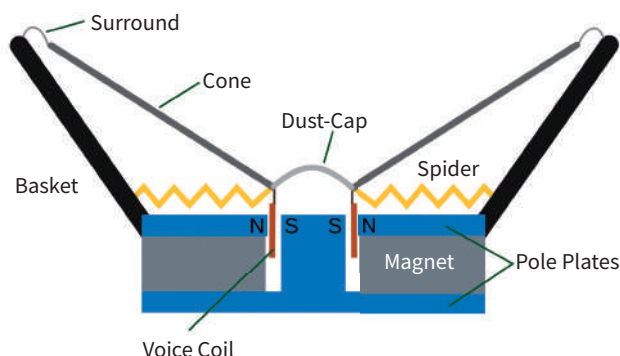


Let's think about this: we all know how different our studio recordings may sound through a different pair of monitor speakers or reference headphones. As well as our HiFi system, our Car Audio or our gaming setup, down to our laptop or smartphone. Not to mention the Sound Reinforcement rig we use for our live gigs or the resident sound system of our favorite club. At the end of the day, everything we strive to play or record in the best possible way comes to our ears through a set of speakers. You change them, you change – almost – everything. Even though, all these speaker systems are designed to perform in the most linear, efficient, and hi-fi like technically possible way, thus the differences among them should ideally be very little, while in the real world, we know they may sound radically diverse.

THE ELECTRIC GUITAR SPEAKERS

In the electric guitar world, the situation is even more variegated. The speakers for electric guitar are not, by any means, linear devices. They are not designed to translate the electric power into sound with the least amount of coloration and distortion. Instead, they are designed to superimpose their own character, color, and harmonics, as they are an integral part of a musical instrument such as the guitar amplifier is. It's no secret that some of the world's best amplifier manufacturers state quite openly that the guitar speaker makes up for 50% of the tone, and maybe even more.

Therefore, let's have a look at what quietly lives behind the grill cloth of our amplifiers!



A BRIEF HISTORY

With today's mindset, we cannot even imagine the astonishment of the San Francisco citizenship when in 1915 Peter Jensen, a Danish engineer established in the USA, performed in the Golden Gate Bridge park the first public demonstration of a human voice, amplified and diffused with the Magnavox, the ancestor of the dynamic speaker as we know it today: a cone membrane, driven by a voice coil immersed in a magnetic field. That's how it all started... Fast forward to the late '40s when Jensen was one of the primary speakers suppliers to the newborn Radio and Public Address markets, and the electric guitar market was being pioneered by companies such as

Valco, Supro, Silvertone, Magnatone, Gibson, Epiphone, and of course Fender.

Jensen became the go-to supplier for the guitar amp industry, and has contributed to the tone of thousands of players and albums that signed off the birth of the modern electric guitar based music... call it rock'n roll if you wish so!

Along the way, also other premium American companies entered the guitar amp market: Eminence, JBL, EV, Utah, Oxford, among others. By the mid-'60s, Jensen provided the voice to all the different generations of Fender amps, from the Tweed amps to the Blonde, the Brown, and finally the Blackface. On the other side of the pond, Celestion started its collaboration with Vox and Marshall, and Fane with Hiwatt and Laney, among others.

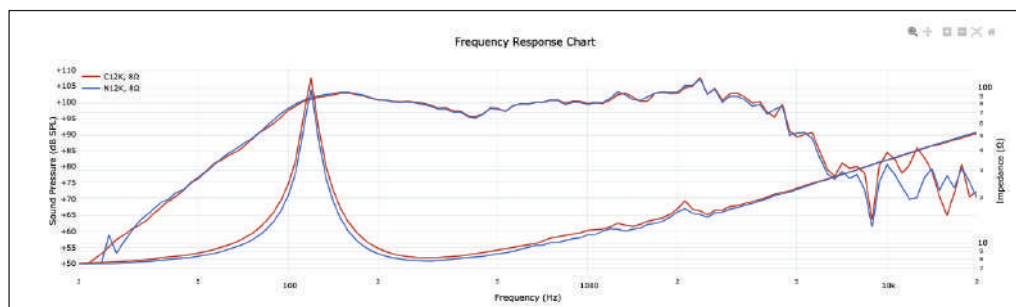
When in 1965 Leo Fender sold its company to CBS, for some (yet unclear!) reasons, the Jensen company lost interest in the guitar amp business, and gradually pulled away from it. Sadly, right on time for the explosion of the British Blues and Rock phenomena, with worldwide acts such as the Beatles, Rolling Stones, Cream, Led Zeppelin, Free, and iconic players such as Eric Clapton, Jeff Beck, Jimmy Page, Ritchie Blackmore, Paul Kossof, among too many others to mention. This questionable decision left the market wide open for its competitors, especially for Celestion which grew up to the leading position they still hold today.

Fast forward again to the late '90s: in the guitar business was starting the "vintage reissue" trend. Fender and Gibson among others, debuted a selection of vintage inspired guitars, basses and amplifiers, effectively starting a new market. In those days, a group of guitar fans and collectors, including myself, was working for the Jensen Consumer Electronic distributor in Italy. We asked permission to the Jensen company to venture into recreating the vintage Jensen speaker range, with the goal to supply the historical partners and the new generation of guitar players. It turned out harder than what we thought since there was no technical archive that survived along with the many ownership changes that Jensen went through over the years. The entire R&D process was therefore based on searching for information (when the Internet was not even close to what it is today) and mostly on shopping for vintage amps and speakers, and reverse engineer them.

Long story short, in the year 2000 the "new" Jensen Speakers, manufactured in Italy by SICA Altoparlanti, debuted at the Nashville Summer Namm... and the rest is history.

WHAT MAKES A GUITAR SPEAKER DIFFERENT?

While we will look at the components that make up a speaker and how they influence its tone, we always have to keep in mind that the speaker is a "system" on its own, where each parameter influ-



This is how similar neodymium and ceramic speakers can be: Frequency response and impedance curves of the Jensen C12K and N12K in comparison.



ences many others. Voicing a speaker consists in balancing these factors to achieve the desired flavor.

A speaker for electric guitar is noticeably different from a speaker for bass, or for Sound Reinforcement, let alone those for HiFi and for Studio Monitors application. All those speakers are designed to reproduce the incoming signal with the less possible coloration and distortion while maximizing the sensitivity. They are engineered to behave as linear as possible, with a behavior resembling the ideal concept of a “piston-like” movement.

On the contrary, a speaker for electric guitar is designed to reproduce a relatively narrow frequency band, usually between 80Hz and 6kHz, where most of the information is rooted. Furthermore, they are an integral part of the sound design, meaning that their tone is optimized to generate a quite specific character, with a controlled amount of harmonics (distortion, that is!), even at a very low volume. As a matter of fact, their frequency response is far from linear, and their movement is equally far from being “piston-like”. In a nutshell, they are an integral part of the tone and play a key role in defining its character.

Let's take a quick look at the basic elements of a speaker, and see how and why their building characteristics influence the tone.

● THE CONE MEMBRANE

The most visible of all components is the membrane, or cone. Almost invariably, it's made of paper, or rather of cellulose pulp, in many formulations to have more or less mass and rigidity. While in the bass, hi-fi, or sound reinforcement applications is not uncommon to find membranes in polypropylene, carbon fiber, aluminum or fiberglass, to achieve the maximum rigidity and “pistonlike” movement, paper is by far the preferred material for guitar speakers. It's very light, and this contributes to the very high efficiency that is typical of those speakers. It's relatively soft and this helps in creating those overtones (i.e. “con-

trolled distortion”!) that contribute to enrich even the cleanest of the guitar tones. This thin, lightweight flat membrane is printed – or “formed” in a tooling mold - to achieve the cone shape, or alternatively, the flat paper foil is bent to form a cone and then joint and glued onto the seam. Many vintage-style membranes are “seamed”, while the majority of modern speakers are formed. As with all other characteristics, also these two build techniques have an effect on the tone. The glue on the seam will add weight and rigidity to the cone, increasing the bass response, but may reduce slightly the sensitivity or efficiency of the speaker.

The membrane can be further mechanically treated to carry a corrugation pattern. These corrugations, often called “ribs”, serve to control the rigidity of the membrane, reinforcing its resistance to bending out of its original shape, under the push/pull movement created by the voice coil. The size, number, and placement of such ribs impacts different frequency ranges, and are an important element in the sound design of the membrane. In general, a flat membrane may “flutter” more, creating more harmonic distortion; the corrugations help to focus such harmonic distortion in the range where the designer wants it. A bass speaker or PA woofer will have much heavier and thicker membranes, more rigid, with pronounced ribbing, to reproduce the bass range with the minimum possible distortion.

A much-debated aspect is the “doping” of the speakers. Many membranes are treated with one or more layers of chemical paints, that can contribute to fine-tune the performance of the speaker. Certain paints may add mass and rigidity, influencing the response in the bass range. Others will soften the fibers of the paper pulp, adding compliance (i.e. flexibility).

● THE SURROUNDS / SUSPENSIONS

Bass or PA speakers will also show undulated cloth or rubber surrounds (or “suspensions”) where the membrane joins the speaker basket frame. The suspensions shall be elastic enough to allow the speaker movement, but rigid enough to control the excursion. Instead, almost all guitar speakers have a different suspension system: the membrane itself extends onto the basket edges, where it's glued on the frame, and locked under a gasket. The edge of the paper membrane is mechanically formed into two or more “wave-shaped” surrounds. In essence, the edge of the membrane is the suspension itself, and thus it's called “integrated paper suspension”. Once again, this will influence the response on the bass range. A cloth or rubber suspension will allow more excursion and a cleaner tone. The paper suspension may be less efficient in the deep bass range but may have a livelier, punchier tone in the low-midrange frequency range, where most of the guitar fundamental tones are generated.

● THE DUST CAP

In the center of the membrane, there is the dust cap, which literally has the function of blocking dust and other particles to penetrate into the gap of the magnet where the voice coil is located. Once again, the size and material of the dust cap influence the tone. The larger the dust cap is, the earlier the speaker will lose energy on the treble side. Technically, a larger dust cap will lower the “cutoff” point, where the guitar speaker will start losing energy. In general terms, the cut-off point in the frequency response of a guitar speaker should be somewhere around 5kHz to 8kHz, to avoid excessive “fizziness” in the tone, especially with overdriven or heavily distorted sounds, that are by themselves incredibly rich



1 Formed cone - copious corrugations - untreated surrounds - paper dustcap

2 Formed cone - treated surrounds - large cloth dust cap

3 Formed cone - heavy surround treatment - cloth dust cap



4 Seamed cone - treated surround - cloth dust cap

5 Seamed cone - light corrugation - untreated surrounds - felt dustcap

6 formed cone - no corrugations, treated surrounds - cloth dustcap

7 formed cone - no corrugations - untreated surrounds - paper dust cap -

in high-frequency content. As far as the most commonly used materials, a heavy felt cap will dampen the upper trebles more than an acoustically transparent cloth cap, and likely less than a paper or aluminum cap.

● THE VOICE COIL

Behind the membrane, we will find the voice coil, one of the key elements in the final tone of the speaker. In essence, it is a coil of metal wire windings, wrapped over a cylindrical “former”. Guess what, size, diameter, and material of the wire... influence the tone. The most common winding wire is Copper. However, there are some good examples of Aluminium-wound voice coils, among other metal wires. Once the voice coil is wound, it is then treated with resins and glues and “cooked” at a very high temperature, to make sure that the wires will adhere to the former, and won’t vibrate or move even under maximum stress or heat.

The diameter of the voice coil is relevant to both the tone shaping and to the power handling of the speaker. All else being equal, a larger diameter voice coil will better dissipate the heat generated by the movement, thus handling more power. In terms of tone, a smaller voice coil will be lighter, therefore very efficient and will have a tone with a definite accent on the upper midrange and treble ranges. A larger voice coil will intuitively be heavier, will take more power, will have a smoother tone on the treble, rolling off the top end. Not only, the diameter will also impart a specific and characteristic fingerprint on the midrange character. In the guitar applications, the most common diameters range from 1” (25mm) to 2,5” (64mm). As an example, almost all of the Celestion guitar speakers use a 1 3/4” (44mm) copper-wound voice coil, and they all share a certain grunt and aggression in the midrange that is an unmistakable factor in the “British rock tone”, that they represent so well.

The Jensen vintage speakers have historically smaller diameter voice coils, offering a somehow brighter tone, while some of the latest speakers in the Jet series have 2” (50mm) voice coils, for a higher power handling and a smoother tone in the top end. The revered EVM12L by Electro-Voice, used in many boutique amps, has a massive 2,5” voice coil, that contributes to its very high power handling and headroom.

The voice coil former has its relevance too: most vintage speakers had treated paper formers. Changing the former material to a formula-

tion that will better resist to the heat stress may significantly increase the power handling of the speaker. Paper formers have a relatively low resistance to heat, while other materials such as Kapton, Nomex, Fiberglass offer a much greater thermal stability, thus a higher power handling. In our development of the Jensen Vintage Reissues we found that changing from the paper formers to the Kapton former meant nearly doubling the power handling of the speaker. The hard work consisted in finding the right Kapton foil to have the closest possible tone to the original paper... and making this change, that we felt was necessary for today’s power handling and reliability requirements, acceptable for the “vintage purists”...

The former is held in place by the “spider” a concentric suspension system, that serves as the “back suspension” of the speaker, controlling the excursion of the voice coil. The spider is usually made of synthetic cloth, formed with concentric undulations, and treated to get to the targeted flexibility.

● THE MAGNET

Finally, the magnet, the engine of the speaker. Back in the early years the magnets were not “permanent” but rather were magnetized by means of a powered transformer. Later on, permanent AlNiCo magnets became the norm. AlNiCo stands for a cast of Aluminium, Nickel and Cobalt, that is permanently charged by an industrial magnetizing device. From the ‘40s until the early ‘60s, nearly every speaker, for guitar or any other application carried an AlNiCo magnet.

The classic AlNiCo tone of the vintage speakers imparts a sweet, musical, progressive dynamic compression of the signal, that gradually becomes more evident at the increase of the loudness. The other element that contributes to the AlNiCo tone is a chiming top end and a warmer, slightly softer bass end, both mostly due to the specific behavior of the impedance curve that the magnet generates.

In the early ‘60s the industrial price of the raw materials needed to build AlNiCo magnets raised up to an unbearable level, pushing the manufacturers to switch to ferrite magnets, a.k.a. “Ceramic” magnets, that are still today the vast majority of the speakers produced. A ceramic magnet is substantially cheaper than an AlNiCo one, but also much heavier and physically larger. Sonically, a





ceramic speaker will show less dynamic compression, a tighter, firmer tone with slightly less “air, chime and openness” than an equivalent AlNiCo speaker.

As such, it is not necessarily “worse” or “better” than AlNiCo, rather “different”, and these slight differences in feel and behavior contributed to the more straightforward, “in your face” attitude of the new, louder, and harder rock’n roll music of the late ‘60s. The Ferrite (or Ceramic) speakers have been the mainstay in the Fender tone since the Blackface and Silverface era, as well as in the British tones (with the exception of the earlier generations of the Vox AC30, that used the mythical G12-T530 AlNiCo Blue Celestions), until today. Starting from the first generation of the G12M-20 Greenback, to the G12-65, to the Vintage 30, and the Creamback family, among many others, these speakers set the foundation for classic, modern and contemporary rock tones. AlNiCo has seen a partial resurgence in the last years, as some manufacturers started to offer a few models in the upper range of their catalogs, usually destined to the aftermarket high-end replacement, and to boutique manufacturers: Celestion has the Blue, Cream, Gold, and Ruby AlNiCo speakers, Jensen has the Blackbird range, among other notable ones by Eminence, WGS, Weber, and then quite some.

In the last 20 years, Neodymium, a new magnetic material has gained a lot of interest, because of its favorable ratio between weight and power. A Neodymium magnet can be 10 times more powerful than a ferrite magnet of equal size, or 1/10th of the size of a ferrite magnet of the same power. It is a very expensive material, but because of its power, the overall size is very small, so the final cost of a comparably powerful magnet is higher than the cost of a Ferrite magnet, but not unbearable.

Initially, it has been used for Sound Reinforcement and Touring PA speakers, where every Kg saved is an obvious advantage. Then Neo speakers found their way into the Bass guitar amplification, where, as of today are the norm and not anymore the exception... and a very welcome new norm, according to your bass players friends, quite relieved of carrying around much lighter amps, thanks also to the common use of D-Class solid-state power stages! However, in the guitar community, the early years were not easy at all for Neo



Jensen C12K with ceramic magnet - a classic in many Fender combos



The neodymium version of the C12K is the N12k

speakers... The industry was so used to the tone of the ceramic speakers that took them a while to optimize the tone of the Neo speakers. Therefore some of the first Neo speakers had a slightly different tone and feel, that many players were not happy with. From the Jensen perspective, in general terms, a Neodymium magnet behaves somewhere in between a ceramic and an AlNiCo one, somehow closer to the latter one. When we realized this specific character of the Neo magnets, we experimented in designing and voicing a new generation of Neo speakers, as if they were carrying an AlNiCo magnet, something that came quite natural to us, considering that we have some decades of experience and heritage in this process... and that was the Jensen way to the 2nd generation of Neodymium speakers for guitar.

In essence, as of today, the guitar speakers manufacturers are perfectly capable of producing Neo speakers that sound and feel as good as their AlNiCo and Ceramic siblings. A good example may be the Celestion Creamback Neo, that may sound slightly different, but has absolutely nothing to envy to a Creamback 65 in terms of tone, and shaves away a significant amount of weight from your amp or cabinet. Another good example is the Jensen N12K, the Neodymium version of the classic Jensen C12K, the stock speaker in a myriad of Fender amps of the past two decades. Fender wanted “the same tone, in half the weight”... as if that was easy... However, after a bit of homework, the N12K was presented to Fender, which adopted it in the new Fender Tonemaster series of amplifiers.

To wrap this up, a neodymium speaker is not anymore a thing to be approached with any sort of prejudice.

You, the player, may like or dislike its tone, but it won't be the magnetic material to make the difference to your ears. Rather, all the elements in the sound design have been combined with a balance that may not encounter your favor. Now, we hopefully have some more elements to understand how a guitar speaker is made, and how the differences in its construction may impact on its tone. In the second article of this overview of the guitar speaker world, we'll look at the interaction of the speaker with its enclosure, and with the amplifier itself... because the speaker tone is a largely dominant factor in your tone and tone is all that matters for all of us guitar players.●



AlNiCo magnet in a compact Horseshoe design on a Jensen P10R



Large AlNiCo slug type magnet on a Jensen P12N

Guitar speakers

part 2



In search of the
“right” speaker



*What makes guitar speakers so special and important, and what should you look for when putting together your speaker/cabinet setup? **Jensen Speakers specialist Ignazio Vagnone** sheds some light on the subject ...*

In the first part of our journey in the world of the speakers for electric guitar, we focused on how they are designed and built, aiming to understand the key differences among the most popular styles. Now, let's try to understand which speaker may be the right one for us, why it is, and in which cabinet it will deliver the tone we always wanted to achieve.

As we discussed in the previous part, a speaker for electric guitar is by no means a linear device. Each has its own frequency response, so it will color your tone in a specific way. Each impedance curve will interact differently with the output stage of your amplifier. The spectrum of the generated harmonics will enrich the sound in a unique and individual fashion. So, how can we select the right one for our dream rig? Without getting too deep in the technical specifications (no, we will not be discussing the Thiele-Small parameters here!), let's try to identify what build characteristics can make the most obvious tonal differences, and how to manage them.

TEXT: **IGNAZIO VAGNONE**

PHOTOS: **STORK, JENSEN, TUBE AMP DOCTOR**



THE PERFECT ALL-AROUND SPEAKER? SORRY, NOT OF THIS EARTH.

There is no such thing as a perfect speaker, that could grant at the same time crystal clear trebles for your clean tones, deep basses, warm midrange, grunt and punch for your overdriven tones, and so on and so forth. Much like a guitar pickup, a speaker's tone is a finely tuned balance between all the elements that the designer has mixed to achieve a specific voice. Furthermore, as we'll see later on, the tone will be substantially influenced by the cabinet materials and design, as well as by the interaction with the amp's output stage. In a nutshell, we should be looking at the amp/cab/speaker as a system, where all elements interact to create the tone. However, a little bit of knowledge will surely help us and narrow down our panel of choices to the most appropriate candidates. It may not be necessary to become an acoustic engineer and grasp all the subtle parameters, but a basic understanding will guide us in our tonal adventure. And after all, don't we all spend endless nights reading about pickups, pedals, strings, tonewoods, tubes... let's carve out a little bit of effort for the speakers as well!

HOW TO CHOOSE "OUR" SPEAKER?

Size does matter. The first mechanical purpose of a speaker is to move some air. Too small, and not much will happen. In the early days, guitar amps had relatively small speakers, 5", 6" maybe 8", as the loudness requirements were small, as well as the output power of those amplifiers.

Along with time, the increase of volume demand brought to more powerful amplifiers, up to 30, 50, 80W, and more. By consequence, the speakers became bigger, with larger magnets and voice coils, to withstand such power. Gradually, the 10" and 12" sizes became the standard in the industry in the late 50s and they still are today. In fact, 10" and 12" speakers usually have a great tonal balance between clarity and depth and can be designed to take an enormous amount of power without blowing up. The 12" size is by far the most popular diameter today. Generally speaking, the larger the membrane is, the more air the speaker will move, ensuring a punchy, powerful rendition. A smaller speaker may „feel“ slightly „faster“, but will rarely exhibit the same full-bodied tone of its big-

ger sibling. However, a 2x10 cabinet will have a bigger radiant area than an equally sized 1x12, so once again, the rule is „there is no rule“!

The cone membrane is pushed back and forth by the voice coil and it physically converts the electric signal into moving air. A lightweight, soft membrane will be very efficient in the midrange and treble range and will exhibit a remarkable amount of colorful harmonic distortion.

A heavier, treated, ribbed, more rigid membrane will deliver a significantly better bass response, with much less distortion, but will be less efficient.

MAGNET TYPE AND SIZE

We discussed the evolution of the magnet types, from AlNiCo to Ferrite (aka Ceramic) to the Neodymium. To wrap this up in the simplest possible way, let's assume we have three identical speakers, where the only difference is the magnet material, and let's listen to how the magnet type influences both the dynamics and the tone.

The AlNiCo magnet will impart a subtle but very musical dynamic compression to the signal... hence it may feel softer and maybe easier, more organic to the player. And, because of a different impedance curve, it will sound slightly more open and chimey, because of its different interaction with the output transformer of the amplifier.

The Ferrite magnet will be tighter and firmer in the bass range and will barely compress the dynamics. As a result, it will sound more straightforward, „in your face“. Less subtle, more present.

The Neodymium magnet will sit somewhere in between, likely closer to the AlNiCo. Slightly softer than the ceramic, still tighter than the AlNiCo, and will show a little bit of compression.

The magnet strength is proportional to its mass, i.e. to the amount of magnetic material. A stronger magnetic field will grant tighter control of the membrane movement. It will be able of a stronger push, and also of a faster brake. A weaker magnet will push the cone less hard, but also will feel slower and looser. If you want deep, tight, powerful bass, you will favor a strong, large magnet. If you want a fatter, warmer tone, maybe a smaller magnet could be more forgiving.



Different cabinet volumes and rear panels provide extreme differences in sound.



JM Speakers combine a large ported cabinet design with a slanted baffle, for a better bass response and high-frequency dispersion.

Changing the voice coil diameter and material, guess what... changes the tone. Once again, all else being equal, the smaller, the brighter, and snappier. The larger, the darker and warmer. But also, the larger in size, the better it will dissipate the heat, thus the more voltage it will take before burning out. And this consideration gives us the perfect opportunity to consider two highly debated parameters: Power Handling and Sensitivity.

POWER HANDLING AND SENSITIVITY

The power rating of a speaker quite simply indicates how much power it can take from the amplifier without burning out. That simple? Not quite. There are a lot of variables in such a statement that should be addressed to give this statement a proper meaning: for how long? With how much THD (Total Harmonic Distortion)? In which frequency range? As an example, in Jensen, we use the AES 2-1984 standard: we feed the speaker with a pink noise with a 6dB crest factor, filtered to the working range of the speaker. After 2 hours of continuous testing, the speaker must not show any permanent change in its specifications greater than 10%. This is the standard by which the majority of the speakers for Pro Audio applications are measured, including speakers for extreme

Unlike most guitar cabinets, bass cabinets are often lined on the inside to minimize unwanted resonance. Ported enclosures like this one are by far the most common in the world of bass amplification.



applications, such as large 18" subwoofers for disco or touring sound. This means that a speaker rated 50W by this standard is capable of taking twice its power rating in everyday's use (the 6dB crest factor indicates just that). Considering the „non-continuous“ nature of an electric guitar signal, that basically consists of very quick transients, followed by a short burst of sustained energy, and interspersed by some silence, it comes out pretty clear that this signal is relatively less demanding on the speaker, than, as an example, a sustained synth bass line in a dance track.

Even those few tens of a second of silence in between a power chord and the next one are enough to allow the voice coil to cool down, avoiding the heat build-up that ultimately is the cause of most speakers' failures. We could then conclude that we may safely match a speaker rated for an applicable power of 100W with an amp capable of outputting 100W. But this does not consider the unique power output characteristics of the tube amplifiers. As an example, a typical 4xEL34 amp may be rated at 100W... with 10% THD. But if you will dime that amp, all controls on 10, it might deliver in excess of 180W, with up to 40% of THD, potentially lethal for that 100W speaker!

Therefore, a good „rule of thumb“ is to use a speaker rated about twice the output power of the amplifier, especially if you plan to crank that amp to the max. Still, the rated power handling of a speaker tells us how much it can take, but does not tell us how loud that speaker will sound with a given power applied.

HOW LOUD CAN YOU GET?

The sensitivity parameter indicates how efficiently the speaker converts the electric signal into moving air, i.e. sound. An average guitar speaker is very efficient, generating from 94 to over 100dB of SPL (Sound Pressure Level) with 1 Watt, measured at 1mt. Sensitivity is a logarithmic value, therefore an increase of 3dB in the SPL effectively means doubling the irradiated energy. Or rather, if a speaker generates 95dB with 1 W, it will need double the power to generate 98dB, and four times the power to generate 101dB and so on.

You can also consider this from the amplifier's point of view: changing from a 96dB speaker to a 99dB speaker will give you the same volume increase you'd achieve doubling the power of your amp! Sensitivity is not related to power handling. There are very efficient speakers that can only take a handful of Watts, and

incredibly powerful speakers with a relatively low sensitivity. Thus, with the same 1W of power, a 50W - 100dB sensitivity speaker will sound louder than a 200W - 97dB sensitivity one.

Having a grasp on the sensitivity concept can offer to the player some interesting options. Here some examples: you love your low-power amp, but sometimes you need a little more sound pressure level on stage. You may want to try and change the speaker for a higher sensitivity one. This may boost your loudness, potentially more than changing your amp! Or, just the opposite scenario: how to tame a single channel, non-master volume amp that reaches its „sweet spot“ at a volume that's way too loud for your usual club gigs? Try switching from your 4x12 to a



small 1x12, loaded with a lower sensitivity speaker. Leaving your 4 100dB speakers for a single 96dB one will significantly drop the SPL.

Sensitivity is also important when you are mixing different speakers in the same cab. If the speakers' sensitivity ratings are too different, you'll likely only hear the louder ones, which will completely overshadow the others. The best recommendation is to mix speakers that have sensitivity ratings as close as possible, within +/- 1 or 2 dB, if you want that each speaker (or pair of speakers) to contribute to the overall tone in an audible manner.

A CONE IN A RANDOM BOX?

Not exactly... the enclosure or „cabinet“ is an essential element in the tone of your amp, and contributes greatly to the shape you'll carve for your tone. All elements of your cabinet will have a profound impact on the tone. From the acoustic design to the material, the size and the shape, down to the finish. Let's start with the acoustic design. Most of us know that each speaker has a set of specifications, known as the Thiele-Small parameters, that determine the acoustic design, size, and overall dimension of the ideal

amount of „openness“ of the back side can go from nearly completely open, down to about 1/3 of the overall back panel surface. If the back will be closed for more than 70% or 80%, it will gradually behave more like a ported (bass-reflex) cab... but more of this later on...

It's obviously very well suited for clean tones, as well as for medium gain ones, up to some „classic rock“ applications. Also favored by those „boutique“ high-end builders who search the maximum purity in the tonal balance, with excellent detail and dynamics. It's a rather efficient acoustic design, as the back-side emission reaches the room almost equally as loud as the front one. The efficiency of the system and the relative ease of design and build are some of the reasons why it still is the most popular design especially with low/mid-power and small/medium-sized amplifiers.

CLOSED BACK CABINETS:

The large, closed-back cabinets came around in the early 60s when Pete Townshend asked Jim Marshall to build him louder and bigger amps and cabs for his explosive guitar playing. Originally Pete wanted a single 8x12, and, in spite of Marshall's concerns,

ended up in having some built. His roadies very quickly made him rework those colossal towers in some more manageable 4x12... and the rest is history! Acoustically, a closed-back cabinet is slightly less efficient than an open-back. This is because the cabinet is „air-tight sealed“, therefore the speaker needs to „win over“ the resistance of the volume of air in the cabinet. Basically, the speaker needs to compress the air in order to move backward and to expand it to move forward. The bass range may extend deeper than with an open back, but in a more linear fashion, without the typical „bump“ around 90-120Hz. Also, the upper treble may be less evident than in an open back cab.

The key differences for a guitar player are the dynamic feel and the dispersion: the closed-back cab will sound more „compressed“ and focused. This character

may generate a bit of a dry, tight feel with the cleaner sounds, but lends itself extraordinarily well to any overdriven and heavy distorted sound. Not by chance, the 4x12 closed-back cabinet has quickly become the voice of the hard and heavy rock.

Additionally, a closed-back cab has a very directional emission, firing at a quite narrow frontal angle, and rapidly losing energy off-axis. The exact opposite of the open back cab, which has a wide, open dispersion. This makes the closed-back cabs very predictable and manageable on stage, containing the leakage of its loudness to the other band members – even at the cost of being very loud for the front rows of the audience!

PORTED CABINETS:

Ported cabinets are newer and relatively less common in guitar amplification, as the first examples date back to the 80s. It is a very interesting solution for a number of reasons. A ported (bass-reflex) enclosure is the only guitar cab that must be designed in compliance with the Thiele-Small parameters of the speaker that



Closed 2x12" speaker cabinet with rear mounted speakers.

enclosure for that unique speaker. There is little of voodoo or magic, but rather designing an enclosure for a speaker is a solid, scientifically rooted process. This is true in almost all applications... unless we're building an enclosure for a guitar speaker. Once again, the guitar speakers are so different from a HiFi, Studio or Sound Reinforcement woofer, that the scientific side of things is much less relevant, and the taste and experience of the designer plays an invaluable role.

OPEN BACK CABINETS:

In the early years of the electric guitar amplification, nearly all amplifiers were open-back combo amps. An open back cabinet delivers a very open (doh!), uncompressed rendition, airy and natural, and fills the room in a quasi-omnidirectional fashion on the lower frequencies. The bass range has good depth and a nice „transparent“ character. As a general rule, the bigger the cabinet is, the bigger the tone and the more bass it will deliver. The



Classic closed 2x12" construction with front mounted speakers for a slightly wider dispersion and felt on the baffle to absorb unwanted reflections



Mesa Boogie also offers speakers that operate in different chambers with open or closed back.

will be mounted in. In strict theory, it should be designed and optimized for a single and unique speaker. Nevertheless, with a certain degree of compromise, it is possible to design an enclosure that will behave correctly with the most common guitar speaker. The principle is to design a sealed cabinet, and add a „port“ or a „duct“ on the front baffle (or, less commonly, on the rear panel). The duct will carry a calculated portion of the rear emission of the speaker to the listening environment, and add it to the front emission, thus reinforcing the response on the lower frequencies. The frequency where this reinforcement is centered is called the „tuning frequency“ and is commonly set in the 65Hz to 90Hz range. The most evident advantage of a ported enclosure is a deep, fast, and controlled bass response that is usually unobtainable in similarly sized open or closed back cabs.

In other words, it is possible to design a very compact cabinet, that sounds much bigger and more powerful than you could possibly expect. It is nearly as directional and controllable as a closed-back cab, but at the same time, it is as fast and uncompressed as an open-back one. Ported cabs are usually very versatile and deliver excellent performances in all playing styles. They are becoming increasingly popular with the session and working musicians because of their „big tone in a small format“ uniqueness.

NOT ALL WOODS ARE MADE EQUAL...

And few know this fact more than the guitar players who may dispute all day about the tonal influence of the Mahogany, Rosewood, Maple, Ebony woods that guitars are made of. Well, there is only one other piece of gear that vibrates more than a guitar, and yes, it's your speaker cabinet. Should you care about its wood and build technique? Yes, just as much as you care about your guitar having a alder or ash body, with a set-in or bolt-on neck!

Seriously, materials and build quality have an important influence on the tone of the cabinet. Softer, less resonant materials such as particleboard or MDF will absorb and dissipate more of the speaker vibrations, dulling and attenuating the tone. Baltic birch plywood is often regarded as the ideal material, especially for large cabinets, because of its good weight/rigidity ratio and a solid, articulate tone. In the tweed, blonde, and brownface amps, the front baffles often consisted of a thin, solid pine board, while the sides were pine or birch plywood. Certain high-end builders use solid tonewoods for the cabinet body (Maple, Rosewood, Bubinga, Mahogany, Walnut, Sapele, among others), often paired with plywood baffles.

Each of these woods has a different density and a different resonance quality... as you see, there is a multitude of recipes, not

even considering the newest wave of builders which offer super lightweight materials such as aero-tech carbon fiber... As mentioned too many times already, each of these combinations will sound different. A solid tonewood board will have a very specific resonance frequency (variable upon the wood and the size), therefore it may impose a specific character to the tone, more than composite materials such as birch, okume, or poplar plywood boards that may be quite more tonally „neutral“.

THE DEVIL IS IN THE DETAILS.

Apparently small details such as the „finger joint“ between the various wood slabs or the bracing of the sides and the baffles will also



The bass response of open (blue), closed (red) and ported cabinets (black) in comparison.



OSB panels consist of much larger pressed pieces of wood than MDF or particleboard and were used, for example, by Ampeg and Marshall in older bass speaker series. Acoustically it is quite suitable for a guitar/bass cabinet, but tends to chip at lower quality.



Plywood is probably the most classic and popular material for guitar and bass cabinets. Especially birch plywood is often used because of its good ratio of weight and stiffness. In the wake of the lightweight trend of recent years, the lighter poplar plywood is also being used more and more frequently.



Particleboard is a relatively heavy and soft material and thus not unlike MDF in its properties. It is also a comparatively inexpensive material, which is usually found in the lower price segment.



MDF is a popular material for speaker cabinets, especially in the hi-fi world. It is relatively soft, hardly resonates and absorbs vibrations, which dampens and darkens the sound. The famous Trace Elliot bass cabinets from the 90s were built from MDF.

determine some specific resonance control. The more braced and more solidly jointed the walls are, the tighter, dryer, and more focused the tone will be.

We should also distinguish the „floating baffle“ cabinets from the „fixed baffle“ ones. Floating baffles are typical of the small/medium size American amps: the baffle is mounted onto the cabinet with usually just a couple of screws on each side, and is „free“ on the top and bottom sides. Being often made with a thin, solid pine board, it is a highly resonant device, that reinforces the speaker emission by sympathetically vibrating together. A floating baffle warms up the tone, and enriches the bass range, especially in medium/small size cabinets. No wonder it works so well together with the chimy sparkling tone of the vintage AlNiCo speakers!

On the other side of the ocean, the traditional British cabinets usually have a stronger, sturdier build, made of thicker plywoods back and sides and fixed speaker baffles, covered with heavier tolex finishing. A fixed baffle is rigidly bolted onto the cabinet, on the 4 sides (3, if it's a front-loaded combo amplifier), thus much less free to vibrate. The entire cabinet build is designed to minimize the vibrations and resonances, relying more on the speaker's own color and tone. These cabinet builds sound usually tighter and more focused. The finishing matters as well: a lightly painted or lacquered cabinet will sound likely more resonant and „alive“ than a heavy tolex covered one. Once again, we guitar players might spend days discussing the effect of Nitro rather than Poly finishing on a solid body guitar. Think about the difference there could be between a solid wood cabinet finished with a few microns thick Nitro lacquer, and a plywood cabinet, covered with a 3mm thick snakeskin-like tolex.

Often neglected, the front grille is another ingredient for our tonal recipe. Certain cabinets have thick, multilayered cloth grilles, that dampen and shape the higher

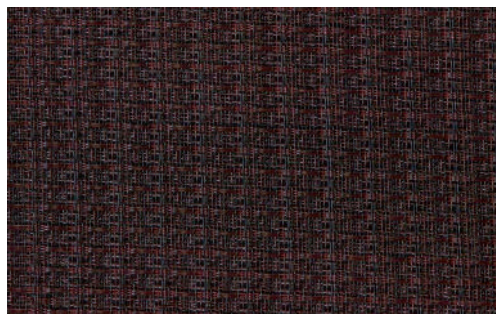
frequencies. Good examples might be the vintage Marshall cabinets featuring the classic „basketweave“ grille. Others are loaded with acoustically transparent cloths, others use metal grilles. These grilles will not affect the treble response, thus allowing more treble energy to be emanated in the room.

Last but not least, there might be an audible difference between a front-mounted speaker and a rear-mounted one. A rear-mounted speaker will „read“ the thickness of the baffle almost like a „wave-guide horn“, narrowing the dispersion pattern of the speaker itself. Such a build technique may result in a slightly more „beaming“ cabinet, compared to a similar one with front-mounted speakers that may sound „wider“ and more open.

EXPERIENCE IS KEY

Just if we thought that „now we know it all“... think twice. There is a multitude of other aspects that for obvious space reasons we could not cover in these articles. And even if we'd do... nothing can ever replace a proper, hands-on playing experience. Not a YouTube video, not the words of so-called „experts“ – including myself!

There always will be a chance of uncertainty about how an amplifier will couple with a given speaker in a given cabinet, in particular with tube amps. Not counting the tonal balance and the amount of gain on tap, the output transformer design, and the topology of the amp itself may influence the dynamics, the focus and the tightness of the overall sound. So, it is science, but not really an exact one! Still, we do hope that having a better knowledge of the basic characteristics of a speaker, and what they mean for the tone, may help you figure out what you really need, to move one step closer to that magic tone, you always heard in your head!



Thin and light front grilles like Fender's 'Oxblood' have little impact on the sound ...



... while heavier and denser grilles like Marshall's 'Basketweave' dampen the treble-response