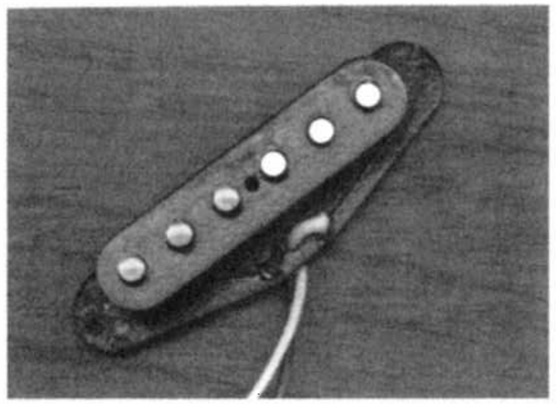
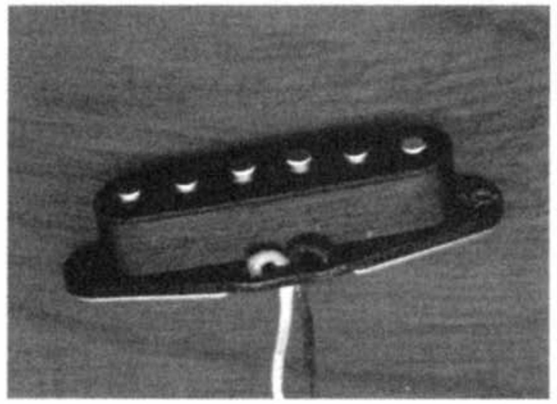
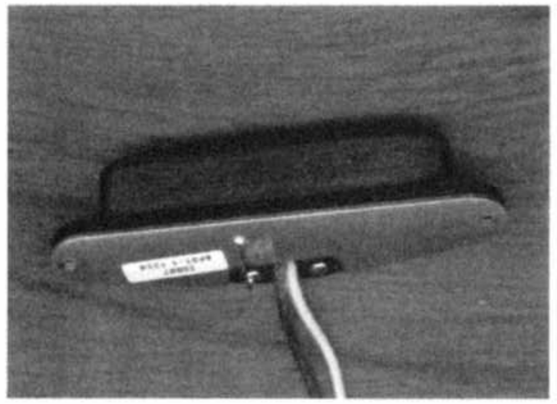


Duncan SSL-52-1 "Nashville Studio", with Alnico 5 magnets for the bottom strings and Alnico 2 for the top strings for a full and sweet sound.





Duncan APST-1 "Twang Banger", made with plain enamel wire, Alnico 2 magnets and copper plated steel bottom plate, to add Broadcaster/Telecaster-style lead unit's punch to the bridge position of the Stratocaster.

Permanent magnets are supposed to lose 1,2% of their power after two years, then about 0,2% in the next thousand years, unless shocks, exposition to high temperature or much stronger magnetic fields affect the alignment.

Our opinion is that the magnets used in the past were weaker than today's magnets of the same grade, even when new.

Anyway almost all makers in order to avoid damage, advise: not to expose the pickups to strong magnetic fields, to avoid shocks or very high temperature, not to leave the guitar leaning on an amplifier, close to the loudspeaker for a long time, or close to big transformers whose intense magnetic field could weaken the magnets.

Seymour Duncan advises, when storing pickups for long time, not to put them one on top of the other, but to leave some distance between them (which is contrary to what happens in most shops).

Generally speaking we are sure that by taking reasonable care of the pickups, they will last without problems, and so be passed on from father to son, in perfect working order. Notwithstanding age, the truth is that in order to use magnets and wire similar to those used thirty or more years ago is not easy, as those materials are difficult to find and expensive. That's why the best quality reissues have such high prices, and sound similar to the classics they imitate.

Most new pickups sound different simply because they are made with different materials, different techniques and are mounted on different guitars and before they change, the chances are that the wood used for the guitar and our tastes will change much more.

The windings

Great attention has always been given to the wire used for the windings. The coil, solicited by the magnetic field running through it, when this is disturbed by the string's movement, generates the electric signal going to the amplifier. The gauge of the wire and the number of turns are of great importance in determining the quality of the signal: too many turns and the sound will lack high frequencies, too little and the output level will be not high enough.

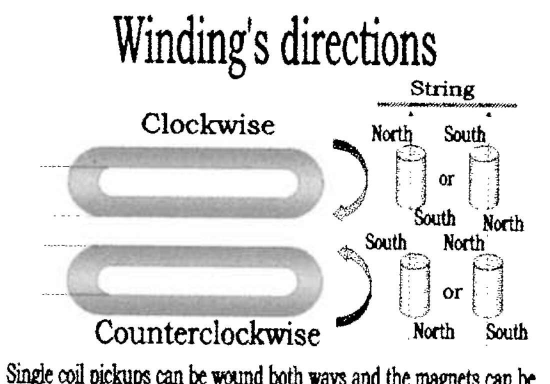
The thinner the wire, the higher the resistance / length ratio.
The further the windings are from the magnets or polepieces, the less they will be solicited by the magnetic field.
The more turns of wire there are in the coil, the less extended is the range of the high frequencies.

The way the wire is wound is important too: if the windings are very regular the sound is cleaner and brighter, if they are irregular, with some turns running on top of each other at random, the sound will be more rich harmonically. However, if this is exaggerated there will be undesired distortions and eddy currents will limit the sound's clarity.
The gauge of the wire is given in AWG, which stands for American Wire Gauge, and indicates a diameter which decreases as it's number increases so, for instance, an AWG 43 wire is thinner than an AWG 42 wire and so on. The wire is made from pure copper with different kinds of insulation, to avoid short circuits, and the specifications might refer to the diameter of the wire only or to the wire including the insulation. This is an important difference because it means that the insulation can vary in thickness (other magnetic materials could be used, for the wire, but copper is the one with the best cost/sound quality ratio).
Below is the nominal diameter of some gauges of wire and the resistance in Ohms for the same length.

American Wire Gauge	Inches	mm	Ohms at 20°C
AWG 38	0,0040	0,1107	648 Ohms/1000ft
AWG 40	0,0031	0,0799	1080 Ohms/1000ft
AWG 42	0,0025	0,0633	1660 Ohms/1000ft
AWG 43	0,0022	0,0564	2140 Ohms/1000ft
AWG 44	0,0020	0,0508	2590 Ohms/1000ft

If we suppose to wind a Stratocaster pickup with ft. 3700 of AWG 42 wire, the resistance would be of 6,142 kOhms, using the same length of AWG 43 the value would raise to 7,918 kOhms. Using AWG 44 an even higher resistance of 9,583 kOhms could be obtained.

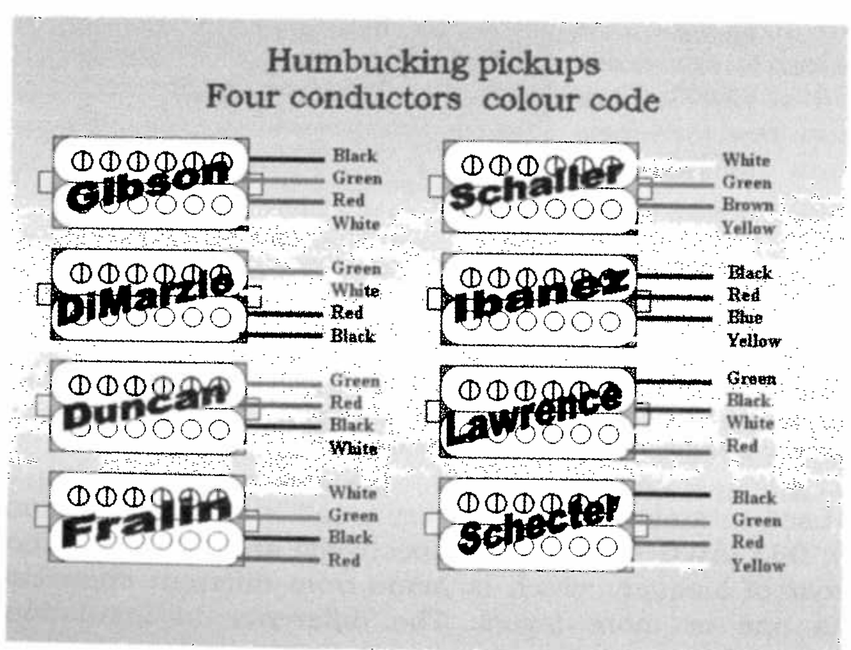
The diameter of the wire used to make pickups is very small, the most common being of mm. 0, 056 or 0, 063 (AWG 43 and 42 respectively) and the insulation consists in a very thin coat of lacquer, which is made from different chemical formulas, and applied in one or more layers. The difference in insulation thickness, between two brands, may seem irrelevant but becomes important if we think that in a P 90 winding there are about 10000 turns and in a Stratocaster pickup 8700 or 7600 turns, depending on the era. With such a high number of turns, even a minimal variation in thickness can make the outer windings a little closer or further to the magnets or polepieces, sometimes enough to affect the timbre.



Single coil pickups can be wound both ways and the magnets can be inserted with the north or south poles toward the strings.

Often when a pickup is rewound, it's difficult to get exactly the same sound as when it was new. When it is necessary to rewind a pickup it is important to take note of the gauge of the wire, the direction of the winding and the number of turns. Even using the same number of turns and the same gauge of wire, the insulation on the new one can be made using more layers of lacquer or from a different material and that can change the specifications.

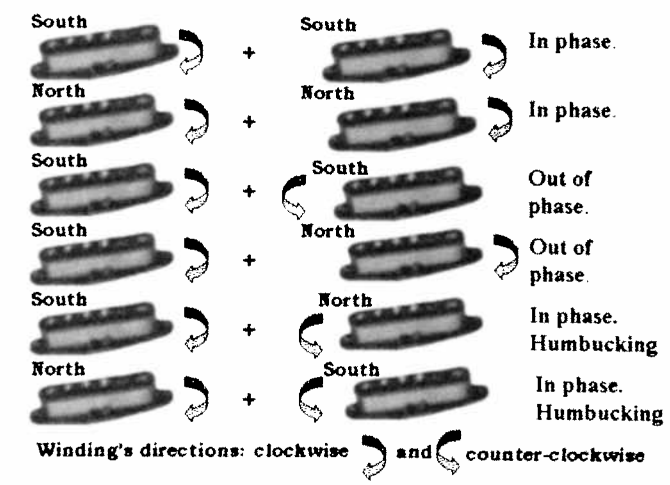
The direction of the winding is important to make sure that the pickups are in phase with the others, on guitars with more than one unit. To ensure that two pickups are in phase with each other, they must have the same magnetic polarity and the windings in the same direction or opposite polarity and opposite windings. Most models are standardized, for instance humbucking models have, almost always, south polarity on the adjustable poles, north on the fixed poles with anticlockwise windings. Fender style pickups have south polarity toward the strings, north toward the bottom. Occasionally on humbucking pickups, the direction of the windings doesn't follow the Gibson standard. Also on many models with three or four conductor cables, each maker uses a different code colour, therefore things can become confusing when mixing models from different brands.



Code colour used to identify the wires from each bobbin on pickups from the most popular brands. Although the scheme can be helpful to confront the different codes, it's necessary to keep in mind that not always the coils are wound in the same direction. Usually, following the Gibson model, the windings are made counter-clockwise. In case a pickup results out of phase with another, will be necessary to reverse the hot output and the ground, corresponding respectively to the red and the green wire on a DiMarzio model.

Fender, over the years, changed the direction of the windings and in the beginning the magnets were inserted with the north facing the strings. In order to reproduce the vintage models of those years, some makers changed the specifications accordingly.

The winding can be done clockwise or anticlockwise, to find out whether two single coil pickups are compatible follow the scheme:
1) Same direction of winding and same polarity - in phase without humbucking effect.
2) Opposed direction winding and opposed polarity - in phase with humbucking effect
3) Same direction of winding but opposed polarity - out of phase
4) Opposed direction of winding and same polarity - out of phase



Modern Fender pickups for the American Standard Stratocaster, for instance, are wound anticlockwise and have south polarity toward the strings, the middle unit has clockwise winding and north polarity, to obtain hum rejection when used with any of the other two.

The first pickups using this system were those of the Fender Duosonic, with a reverse wound and north polarity neck unit, also the two units, when selected together, were in series, for a fuller sound with humbucking effect; the first maker to use a reversed wound/reverse polarity pickup in the centre slot of a Stratocaster was Seymour Duncan.

Supposing we need to substitute another brand of pickup for the bridge unit, for instance with a Duncan, we have no problems if we chose a SSL-1, SSL-2, SSL-3, APS-1 or APS-2 as well as any of the same production line, because they are all made with the same winding direction and magnetic polarity as the Fender. A Duncan Antiquity Texas Hot, wound clockwise and with north polarity, would be in phase with the middle pickup, but without humbucking effect; A Duncan Antiquity 2 Surfer, wound clockwise and with south polarity, would be out of phase.


Fender Mustang. Introduced in 1964 it was an improved Duo-Sonic with contoured body, vibrato and more versatile circuitry (A. A.).

This means also that we must pay attention even when using models from the same maker but from different series because, in our example, the Surfer would be out of phase with other Duncans in the standard line, such as the SSL-1. Once we know this, there is always the possibility of ordering the desired model with reverse winding and reverse polarity (RW/RP), to get humbucking effect if mounted in the middle or to put it in phase with other models.

The wire gauges used to make pickups are many, going from AWG 38 to AWG 44 and for special designs Duncan even used the rare intermediate gauges, like AWG 42,5. Fender and Gibson, used two kinds of magnet wire, on their old models, which were distinguished by the insulation, made of Heavy Formvar or the thinner Plain Enamel. In the seventies the even thinner Polysol was used and is still the standard wire for the American Standard Stratocaster and the Made in Mexico pickups.

The difference is slight but gives different results, as on the Fender Stratocaster pickups, on which AWG 42 Heavy Formvar was used until about 1964, then the introduction of automatic winding machines and the use of AWG 42 Plain Enamel resulted in the same electric specifications with a noticeably different sound. AWG 42 Heavy Formvar was used on most Lap Steel, Duo-sonic, Jaguar and Mustang pickups, AWG 42 plain enamel on Telecaster lead and Jazzmaster pickups, AWG 43 Plain Enamel on Telecaster neck pickup and AWG 42 Polysol on the Fender humbucking and X-1 models.

Seymour Duncan measured the wire used on many Fender pickups from the fifties up to the CBS years and found that the average diameter of the Heavy Formvar type, used in the fifties and part of the sixties, ranges from 0,0027 to 0,0030" (the most common), the plain enamel kind used by CBS ranges from 0,0025" to 0,0027". The thinner insulation permits the outer turns to be slightly closer to the magnets and the use of automatic winding machines gives more regularity to the winding and improves the alignment of the layers. During the sixties Fender also decided to decrease the tension of the winding because with the automatic winding machines of the time the thin wire could be easily broken.

These factors together contributed to a thinner, brighter, cleaner sound on the new models, compared to the older ones.

On Gibson pickups, such as the P 90 and the humbucking model, the wire is, traditionally, AWG 42 Plain Enamel, with a brownish colour. Around 1963 Gibson switched to Polyurethane coated wire, with a clearer, reddish colour. By the end of the sixties the wire used had a dark colour, but was sometimes dark red on some pickups. The sound, all else being equal, was slightly thinner on the treble and darker on the mids, although the change in tone was also due to the use of smaller Alnico 5 magnets, which began in the sixties.

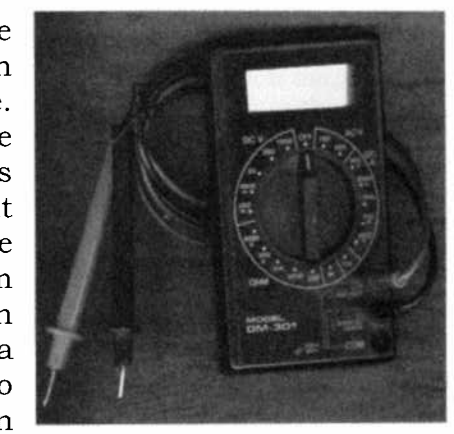
Most replacement pickups have to retain the same dimensions as the originals they are supposed to replace. To make a replacement model for Stratocaster, for instance, the AWG 42 Heavy Formvar wire is used on the best replicas. To get more output on some models, a wire with a thinner insulation, but the same nominal gauge, such as Plain Enamel, can be used to obtain more turns. For even more turns the even thinner Polynylon can be used instead, as on some Fralin models. This means that if with Heavy Formvar we may have a coil measuring as much as 7 kOhms, by using Polynylon we can get up to more than 7,5 kOhms, thus producing a slightly louder, thicker and darker sound.

For hotter models AWG 43 Plain Enamel wire is generally used so as to be able to put many more turns in the same space. For a given number of turns, a thinner

wire has a higher resistance, a lower output and more sensitivity to dynamics. Since the output level is made higher by increasing the number of turns in the winding, it is possible to make a pickup louder by substituting a thinner wire for the original. In this way one is able to wind more turns on the same bobbin, but this method also increases the resistance, thereby reducing the treble content: the pickup will sound louder, with more mids and less highs. D. C. Resistance can be higher than 13 kOhms.

On the very first Broadcaster bridge pickups, Fender used 10000 turns of AWG 43 Enamel wire, with a resistance which could exceed 9 kOhms, Gibson, on the P 90, used the same number of turns of AWG 42 enamel wire on a larger bobbin with a resistance of about 8 kOhms; even though the Broadcaster pickup is louder than later Telecaster pickups using less turns of AWG 42 enamel wire, it's output is lower than that of the Gibson P 90. This example shows how the resistance alone, if the wire gauge is unknown, is not enough to guess the power of a pickup.

Only by comparing two pickups made with the same wire, can the resistance be useful in determining which one is more powerful.

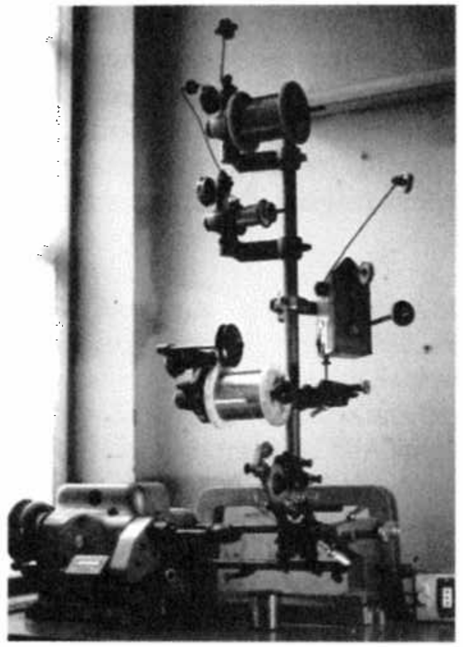


The D. C. resistance can be checked with a simple Ohm-meter, better if digital, and is usually given on catalogues, generally taken at a 68° F temperature. The resistance for any model is usually the value resulting from the average of several units measured, therefore it is quite normal to find slight differences between what's stated on the catalogue and what's found on the pickup just bought from the shop. The resistance increases with high temperatures, so if we measure our pickup in a room with a 96° F temperature we should expect to see some hundred Ohms more than the value given by the maker.

The tension of the winding affects the results. With high tension the wire tends to stretch and become slightly thinner, especially around the corners, with a proportional increase in resistance. The turns may be more or less tight, regular or tangling casually. This depends on whether the wire is hand wound or an automatic winding machine is used and then also on how the machine is adjusted.

In the past a worker used to keep the wire running between his fingers and adjust its inclination toward the bobbin, making, according to his ability, the winds more or less regular and determining how many turns would pile up on each coil. A mechanical counter would show when the number of turns for that model was reached and the worker would stop the machine.

The precision of the counters was not accurate and pickups were not wound to exactly the same number of turns, but to obtain a certain resistance, measured with testers which had a precision of 20% tolerance. The worker could stop the



Marsili winding machine from the sixties (Claudio Prosperini).

machine when required for any reason; add to this the difference of inclination impressed on the wire, the precision of the layers which differed according to each worker's ability and the way each machine was adjusted and it's easy to understand that any single unit would have its own character. (Lets raise a glass in honour to the women and men who while winding every day kilometres of wire, infused their personality to create sounds which made history).

During the sixties automatic winding machines became available, with precise counters and better adjustment possibilities, thus permitting more regular layers, greater consistency in the specifications of the pickups, and gradually reducing tolerances.

By the end of the decade the resistance values of pickups of the same model were fairly similar and the tension was constant without tangles in the coil.

Today most pickups are wound with precise machines (DiMarzio used digitally controlled winding machine from the end of the seventies), on which it is possible to adjust the winding speed and the tension for very tight and regular windings. For the reproduction of vintage models, however, different methods are possible, one adjusting the machine to tangle the coils after each number of turns, a sort of "programmed" irregularity, another is to use original machines and hand guiding the wire (the so called "hand wound" models).

On fifties' pickups the windings were very tight but irregular, when the first automatic machines came into use, to avoid breaking the delicate wire, the windings were made with lower tension, but with more regular layers.

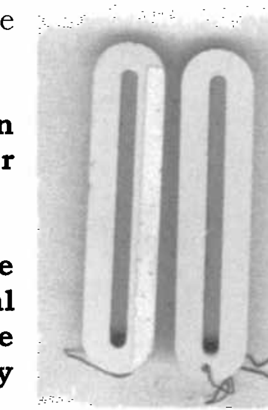
This is why two pickups made in different years, for instance in 1959 and in 1968, can have the same resistance values, but different sounds, warmer the first, cleaner the second.

This happens because irregular windings cause differences in tension between layers, resulting in eddy currents which, if limited, make the sound richer and more harmonic.

Since these differences in tension are unpredictable, even though the number of turns is the same for two pickups, they might have a slightly different timbre.

Although these small details may seem of little importance, all together they can create audible differences between one unit and the other, even if made the same day by the same person.

The most important variables occurring in a coil are the following:



Nylon bobbins from an Höfner humbucking pickup. Thin and less expensive than the plastic ones used by Gibson, nylon bobbins were used by most pickup makers in USA, Europe and Japan. Gibson too, used them in the Melody Maker single coil and in the small sized Epiphone/Deluxe Minihumbucking.

1) Each kind of wire is delivered with some allowance on it's specifications, therefore slight variations in diameter from the nominal value may occasionally occur.

2) When the wire is wound around a bobbin or the magnets, variations in the tension can cause occasional stretch reducing the diameter of small segments of the coil which, when repeated turn after turn, noticeably increase the total resistance of the winding.

3) The coil has its own capacity, and acts as a small capacitor by cutting the highest frequencies. Thus the more turns there are in the coil, the more trebles are limited.

4) Inside each coil there are eddy currents affecting the timbre positively when the phenomenon is limited.

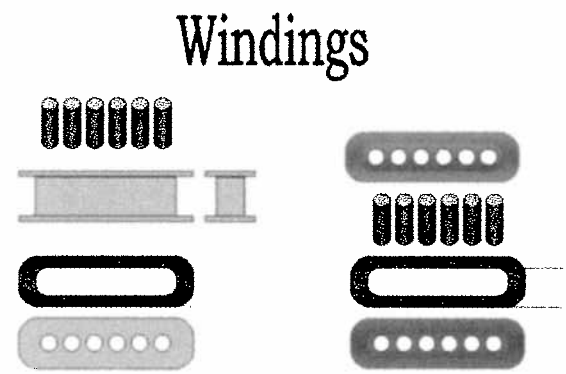
5) The more the turns are regular and have even tension, the lower the content of eddy currents. The sound is cleaner or, depending on taste, less rich; looser windings would give a brighter sound, but if too loose, feedback can become a problem.

6) As with any material, the coil has a resonance and the relationship between the intensity of the magnetic field, the number of turns and other factors determine the frequency of peak level sensitivity (resonant peak). The higher the number of turns, the lower the frequency at which the resonant peak occurs.

Although the type of magnet used is undeniably important, the winding method is much more important in obtaining the final sound.
The use of hand guided machines is a true art, and to understand even the smallest details is fundamental.

Imagine that the amplifier, reproducing the signal a lot louder than the original level, acts as a very powerful magnifying glass.

Lets say that we have two pickups of the same model and there are slight differences in the kind of wire, the number of turns, the tension in the windings and the intensity of the magnetic field. Any of these small differences is then amplified many times by the amp and the total percentage of variations could easily result in concluding that these units are two different models.



On some pickups the coil is wound around a bobbin

On others is wound directly around the magnets

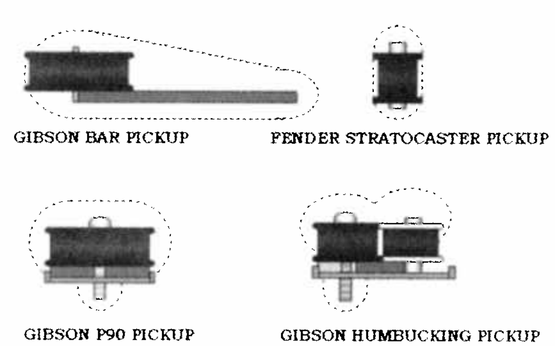
Some pickups have the winding directly around the magnets, others have the magnets inserted into a plastic bobbin around which the coil is wound. With the first method the magnetic field is more effective and the tone has more attack and is more open, with the second the material from which the bobbin is made, even though very thin, puts some distance between the coil and the magnetic field, resulting in a softer tone.

Both methods are correct according to the design of the pickup, but if one of them is used to make a model originally designed using the other, obtaining the right tone could prove difficult.

The Stratocaster pickups, for instance, had the coil wound directly around the magnets, today some copies are made using a plastic bobbin and rely on the stronger magnetic field of modern magnets, but the sound, compared to models using the original method, is less authentic.

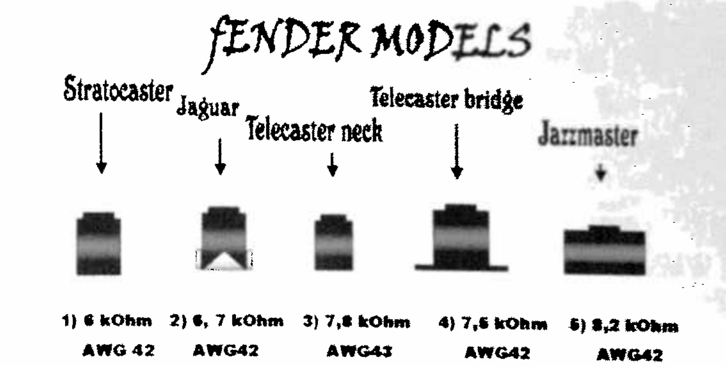
The designer's solutions

The physical structure of the pickup plays a big part in the way the unit sounds. Different solutions in assembling components gives a different shape to the magnetic field and can have a relevant effect on the timbre.



The Gibson bar pickup (Charlie Christian) has two big magnets running parallel to the strings under the guitar top and this is a factor which contributes to the sweet sound characterizing this model, especially if compared to the P 90, which uses the same coil, but has two more powerful magnets parallel to the winding and perpendicular to the strings. The Stratocaster model, with magnets directly under the strings has a very focused field.
The humbucker has a wide magnetic field similar to that of the P 90, but with a slight different shape.

The most popular models produced by Leo Fender are all very simple and with only small structural differences distinguishing one from the other, yet they all have a strong sonic personality.



Fender pickups are a good example on how similar structures can be used, with slight variations, for different sounds:
1) Slim coil.
2) Slim coil with metallic frame.
3) Very slim coil with thinner wire.
4) Coil with bottom metallic plate.
5) Wide and short coil.

The models for Telecaster, Stratocaster, Jaguar and Jazzmaster, are all made by winding a single coil around six cylindrical magnets, but Fender's clever use of variants on this basic concept gives each of them their own signature sound.

The first noticeable difference is in the way the coils look. The Stratocaster and Jaguar coils are tall and slim, the Jazzmaster's is short and fat, the Telecaster's bridge unit is middle way and very thin on the neck unit.

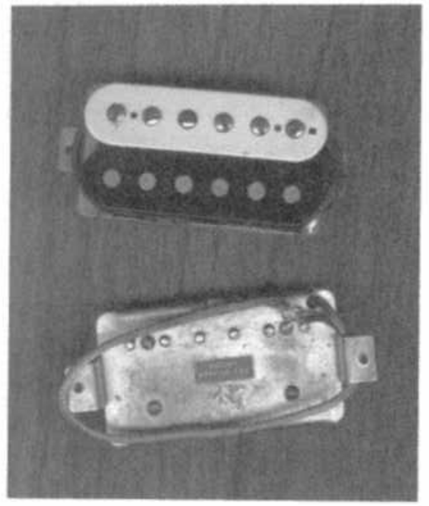
A closer look shows that the Telecaster bridge pickup has a metallic plate in the base, the neck unit has a nickel cover, the Jaguar model has a notched metallic ring surrounding the coil.

There is more: the number of turns in the Telecaster bridge model is higher than in the Stratocaster pickup and even higher in the Jazzmaster unit, while on the Telecaster neck model a thinner wire is used (AWG 43 instead of AWG 42 as in the others) with a slightly higher number of turns than in the bridge unit. The coating protecting the wire is different too, as the Stratocaster and Jaguar units have Heavy Formvar wire coating, the Jazzmaster and Telecaster models are wound with a wire coated with slightly thinner Plain Enamel lacquer.

How do they sound? The Stratocaster model sounds bright but warm, the Telecaster bridge model, more punchy and with a fuller bottom end (thanks to the bottom plate extending the magnetic field and more turns in the windings). The neck model sounds softer and sweeter (the thinner wire has higher resistance and the cover softens the highest frequencies).

The Jaguar model is brighter than the Stratocaster unit because the metallic ring directs a more focused magnetic field toward the strings, the Jazzmaster model has a bigger sound because it has more turns in the winding and a wider magnetic window.

Leo Fender, using a simple basic idea, with clever expedients achieved five different sounds.



The concept behind the humbucking pickup is that two identical signals, with their phase opposed, cancel each other, while two signals with the same phase strengthen each other. The hum runs across the bobbins, which are out of phase, and gets cancelled, the musical frequencies produced by the strings disturb the magnetic field, of opposed polarities, thus resulting in phase with the bobbins. In this way they are not cancelled but strengthened.

The total number of turns in the two bobbins is the same as in the single coil of the P 90 (2x5000), the magnet is only one instead of two, but the actual sound level is equal or even greater, due to the efficiency of the system.

It has a similar timbre and a wide magnetic window due to the distance between the polepieces.

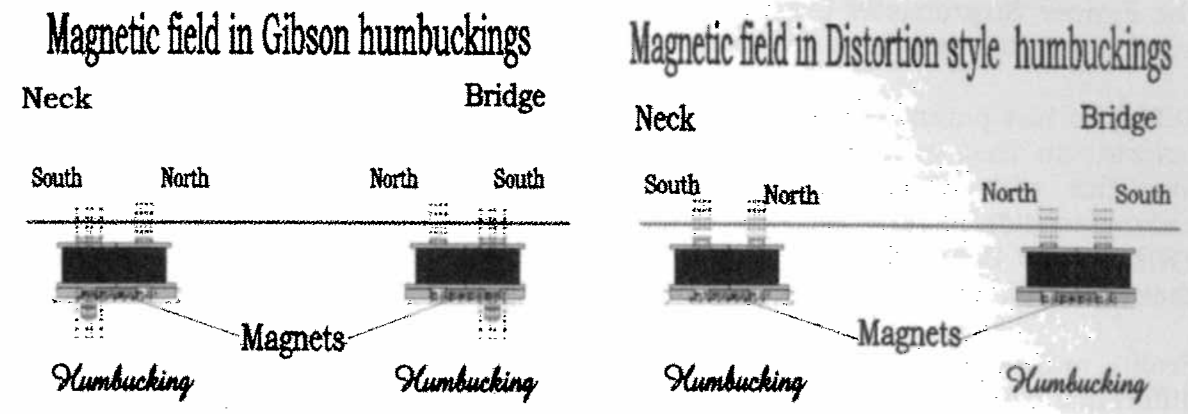
The hum is not cancelled totally because the signal picked up by the two rows of polepieces is not identical and some frequencies get cancelled. The relationship between the width of oscillation of the strings and the distance between each row of polepieces, strengthens some harmonics and cancels those falling in the centre of these two points. Since the highest frequencies have the shorter oscillation, these are the ones most influenced by this phenomenon and this is one of the reasons why a humbucking pickup sounds sweeter than a single coil. Even if the hum reduction is not 100% achieved, it's enough to quieten the pickup and the use of a nickel cover as a shield makes it even quieter.

While the best noise rejection is achieved using two identical coils, in the fifties it was difficult to find precise solutions, so some humbuckings have better matched coils than others. Those with more variations between the coils have a slightly brighter and rawer sound and some players love it, which is why Gibson now offers the Burstbuckers, and produces these units with not-so-well matched coils.

The original structure of the model designed by Seth Lover used two identical bobbins side by side, but in 1969 the low impedance models used on some Les Paul guitars had the bobbins on top of each other, with a magnet in the centre and polepieces running through the coils. Today there are many designs using thin bobbins on top of each other, made to look like single coil pickups, with windings made by utilizing very thin wire. This is necessary to obtain sufficient turns in such a small space. The purpose is to cancel hum while keeping the narrow magnetic window of Fender-style single coil units, but advertising hype notwithstanding, the result is a timbre which is, at it's best, very similar, though never identical to real single coils.

The humbucking pickup, with a magnet under two rows of polepieces, generates a wide magnetic field and a relatively great length of the strings becomes magnetized. The adjustable polepieces, extending over the base of the pickup, through six holes, direct some of the energy in that direction, while the non

adjustable polepieces, leaning on the bottom, are less dispersed, and direct toward the strings a stronger magnetic field, thus producing a slightly more powerful and brighter sound. With the cover on, the magnetic field becomes weaker, so reducing variations. The screw poles can then be adjusted closer to the strings for an even more focused magnetic field and a little more brightness.



On humbucking models with identical polepieces for the two bobbins, as in those with Allen screws, the magnetic field is the same for both bobbins. These are usually sold without a cover.

There are several characteristics which give a pickup it's distinctive voice and these are all interdependent.

The magnet's flux density, the number of turns on the windings, the wire gauge, the shape of the magnetic field, the level of concentration toward the strings, are all factors which affect the output level and timbre.

The resonant peak

The wood and other materials from which the instrument is made, each has its resonance. This is also true of the pickup which creates a sudden increase in level on it's frequency range, almost flat up to that point, which is called resonant peak. After this peak the frequency level decreases rapidly. The frequency at which the peak is reached depends on the power of the magnet, the number of turns in the winding and the structure of the pickup.

The resonant peak is the frequency at which the pickup is most sensitive and the highest limit of acceptable range, therefore a model with a peak at 8000 Hz has a more transparent sound than one that has a peak of 4000 Hz. These details must be thoroughly considered.

A magnetic pickup is not meant to be a high fidelity device, but a component made to enhance the timbre of the instrument with it's musical tone.

The tonal balance of the frequencies reproduced is of utmost importance and a further extension in range is not necessarily more desirable.

The P 90, for instance, has a resonant peak of 4700 Hz, a resistance of 8 kOhms and an inductance of 7,5 Henries and is much loved for its hot and warm sound, the Fender Stratocaster pickup, which has a resonant peak one octave above, is appreciated for its open and clear sound.

DiMarzio has patented some humbucking models with different windings in each bobbin, so that each has a different resonant peak, which is like having an amplifier with a 12" and a 10" loudspeaker thereby producing the sonic characteristics of both formats. This technique is used on models such as the FRED, Tone Zone, Norton, Evolution, Cruiser and others. Some musicians love these results, while others prefer the traditional models.

Fralin makes the Unbucker, a pickup similar to a Gibson style model, the difference being that one of the bobbins is under wound. Uneven coils makes the humbucking effect less effective, but the sound is more open with some of the character of a single coil and a higher resonant peak.
The use of bobbins with wire of different kinds is also common on some humbucking models with stacked coils, such as the Kinman and other models of the last generation of single coil sized humbuckers. Due to the small space available and the thin wire required, which must be wound with great precision, the production of these pickups is very difficult and only possible using high technology winding machines.

In order to comprehend the resonant peak, imagine emphasizing a narrow portion of the audio range using a parametric equalizer. This instrument permits us to choose the frequency, the width of the band and the amount of level increase. On a pickup this is the result of the structural characteristics and the length (number of turns) of the wire in the coil.

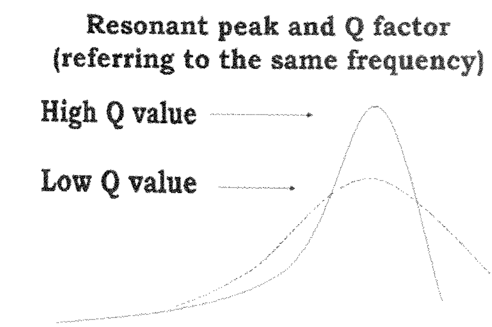
A pickup such as the P 90, with the magnet under the coil, transfers the energy through polepieces and a high resistance. The peak has a narrow band but is very high and occurs at 4300/4700 Hz.

On a Stratocaster model, with its lower resistance and stronger magnetic field of the magnets directly in the coil, close to the strings, the peak is at a frequency well above 7000 Hz, is less pronounced and a larger band is affected. An humbucking pickup has a resonant peak around 5000 / 6000 Hz.

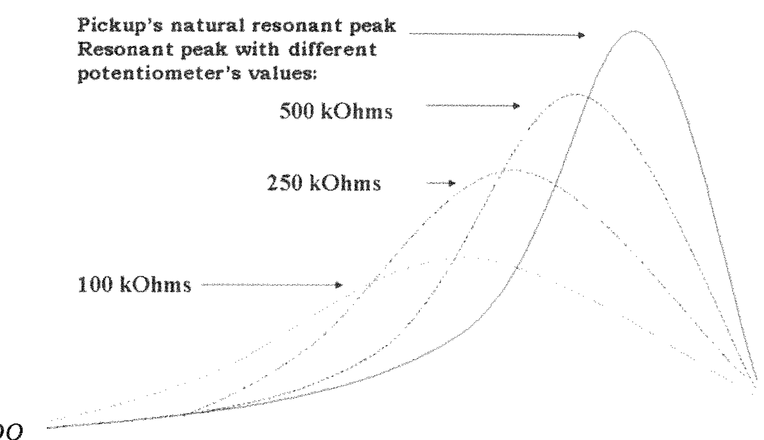
The width of the band emphasized is determined by the Q factor: the higher the value, the narrower the band, in our example they are 5,6 for the P 90, 2,7 for the Stratocaster.

The open and clear sound of the Stratocaster pickup is due to a higher resonant peak with a large emphasized band.
The warm but nasty sound of the P 90 is the result of a narrower band, which has more emphasis, at a lower frequency.

In the graphic the peaks of two imaginary pickups are shown as occurring at the same frequency for ease of comparison.



When the pickup is connected to the guitar's circuitry, the height and width of the peak is modified by the potentiometers. As the resistance of the potentiometers decreases, the peak height gets diminished and it's width increased, the frequency too is lowered.

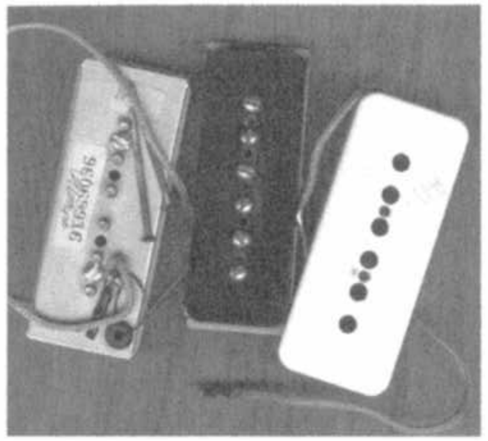


On a guitar with 1 MOhm potentiometers the natural resonant peak is almost completely preserved, with 500 kOhms potentiometers the frequency and the height of the peak is lowered and the band gets larger, with 250 kOhms potentiometers the amount of peak reduction is higher with an even larger band and so on.

The result is that the higher the potentiometer value, the brighter the instrument will sound, for this reason with trebly pickups, as in most single coils, lower value potentiometers are used, to avoid the tone becoming shrill, conversely with warmer sounding units, such as high output single coils and humbuckers, high value potentiometers are preferred to reduce the loss of high frequencies.

The relationship between the coil and the metallic parts of the pickup gives the inductance, measured in Henry, a higher value means a louder signal and less trebles.

Considering the pickups used as an example, the P 90 inductance is between 7/8 Henries and the Stratocaster has about 2/3 Henries. A humbucking pickup, PAF style, has an inductance of 4,5/6 Henries. This value is seldom stated in catalogues, but when available, if the resonant peak of a model is unknown, it is easy to presume that one with an inductance of 6 henries will sound louder and warmer, and will have a lower resonant peak, than a model with 4 Henries.



Duncan Antiquity P 90

By the end of the seventies, probably in order to give an image of professionalism and high technology, most makers used to publish catalogues with plenty of technical information, but later, gave more emphasis to "vintage" models, with more descriptive prose, often colourful and imaginative and less detailed specifications. Several DiMarzio catalogues from the early eighties and recent Duncan Antiquity and Fender catalogues report the inductance values of their pickups. This makes for an interesting comparison, if we presume that the measurements were made using similar methods.

Remember that a higher value means more power and a warmer sound, while lower values indicate less output and a clearer tone.

DiMarzio	Super Distortion	Resistance: 13,68k	Inductance: 8,2h
	PAF	Resistance: 7,65k	Inductance: 4,5h
	FS-1	Resistance 13,35k	Inductance: 6,7h
	SDS-1	Resistance: 8,68k	Inductance: 8,8h
Duncan	Antiquity Humbucking	Resistance: 8,52k	Inductance: 5,12h
	Antiquity Humb. Neck	Resistance: 7,8k	Inductance: 4,22h
	Antiquity P 90 style	Resistance: 8,52k	Inductance: 7,41h
	Texas Hot (Strat Style)	Resistance: 6,3k	Inductance: 2,87h
Fender	Custom 1954 Strat	Resistance: 6,5k	Inductance: 2,75h
	Original Vintage 57/62	Resistance: 5,6k	Inductance: 3h

As a point of reference lets compare these values with those measured on pickups we had the opportunity to test.

Gibson	Patent Applied For c.1959	Resistance: 7,6k	Inductance: 4,26h
	Patent Number c. 1964	Resistance: 7,76k	Inductance: 4,35h
	Patent Number c. 1970	Resistance: 7,81k	Inductance: 4,5h
DiMarzio	PAF	Resistance: 7,87k	Inductance: 4,32h
Duncan	Seth Lover bridge	Resistance: 8,09k	Inductance: 4,8h
	Antiquity Humbucking	Resistance: 8,56k	Inductance: 5,15h
	Antiquity Humbucking n.	Resistance: 7,72k	Inductance: 4,4h
	Pearly Gates	Resistance: 8,13k	Inductance: 5,32h
Fender	Stratocaster 1960	Resistance: 5,65k	Inductance: 2,3h
	Stratocaster 1960	Resistance: 6,02k	Inductance: 2,54h
	Stratocaster 1960	Resistance: 6,12k	Inductance: 2,6h

Even slight differences in measurement conditions and equipment used can cause variations in values, but, on pickups of the same style, the "vintage" models have more or less comparable values to those on original samples.
Others are completely different, for instance the DiMarzio SDS-1, even though its resistance is lower than that of the FS-1 from the same maker, it has a higher inductance and sounds, indeed, closer to a P 90 than to a Stratocaster model, (even a "Hot" one).
The Duncan Texas Hot and the Fender 54 are very similar to original models and their inductance gradually increases when the resistance is higher.

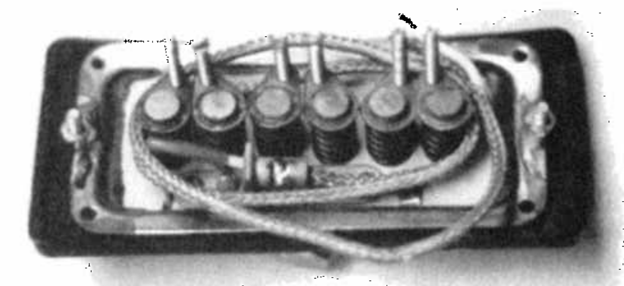
The Fender 57/62, despite a lower resistance, has a higher inductance, and so presumably should produce a cleaner sound, a bit less open, or warmer, depending on taste.

The polepieces

There are different ways for the magnetic field to be concentrated on the strings. There are two methods mainly used on pickups, one is to insert the magnets directly in the windings, under the strings, the other is to put an alnico or ceramic bar on the bottom of the coils, with ferrous polepieces directing the magnetic field toward the strings.

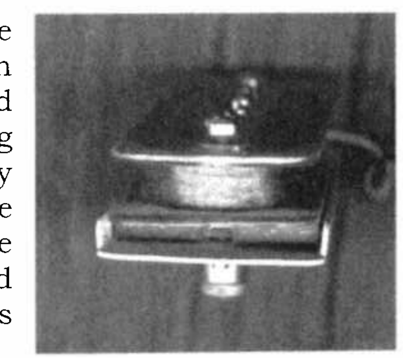
A rudimentary but effective system is the one preferred by Leo Fender, with cylindrical magnets in the coil, a polarity toward the strings and the other toward the base, but this method makes it impossible to adjust the level for each string.

DeArmond tried to solve the problem by mounting each magnet in a cylindrical holder which, by means of a screw and its respective spring, could be adjusted in height to balance variations in output of the strings. A similar system, was used on the Gibson Alnico pickup designed by Seth Lover but instead used square magnets.

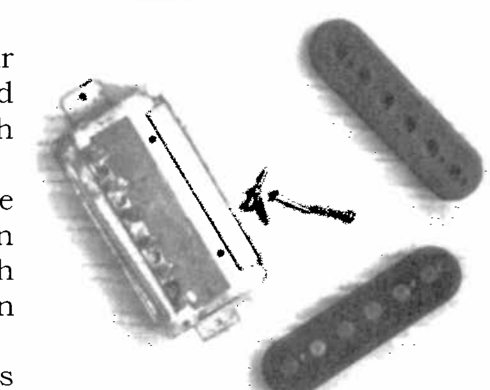


The bottom of a DeArmond pickup, with the magnet holding cylinders and the adjusting screws (Claudio Caldana).

On the Gibson P 90 two bar magnets on the base of the unit, with the south polarity toward the centre, touch six adjustable screws which transfer the magnetic field across the winding to the strings. An interesting peculiarity of this system is that the opposite polarity (north), facing the external sides of the coil, tend to be attracted by the south polarity in the centre, so the magnetic field completely surrounds the pickup and widens the magnetic window. This is one of the reasons for the potent sound of this model.



On his humbucking Gibson used a similar technique, with a magnet under the coils and polepieces in the plastic bobbins around which the wire was wound.
On the prototype Seth Lover used non adjustable cylindrical polepieces, but on the production model one of the bobbins, the one with south polarity, received adjustable screw poles, as on the P 90.
Since the distance between the two pole rows is smaller than that between the external sides of



Duncan SH-AH-1B, designed for Allan Holdsworth. Made with two rows of adjustable polepieces and an Alnico 5 magnet, with windings for about 16 kOhms of D. C. resistance, it has a warm and smooth sound.

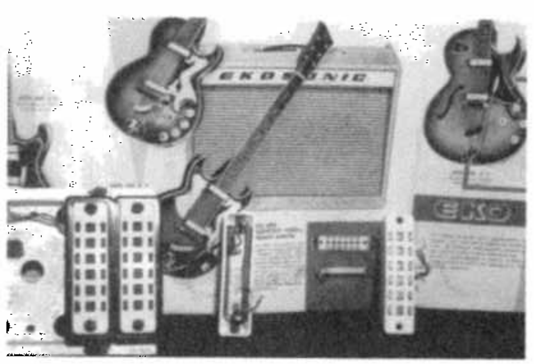
the pickup, the magnetic field is more concentrated and is more efficient than the single coil model.

Therefore even though the total number of turns used in the windings (2 x 5000) is the same as the single coil model (10000 turns) and only one magnet is used instead of two, the result is a comparable output level, a lower inductance and a higher resonant peak.

Gretsch, on the Filter'Tron, used a structure similar to the Gibson, but with adjustable screws in both bobbins. This should allow a smoother sound, but since Gretsch used less turns of wire, of a bigger gauge, the low resistance resulting gives a brighter tone.

DiMarzio, on the Super Distortion, introduced two rows of adjustable Allen screws as polepieces, not extending under the base of the pickup as on the Gibson and the Gretsch, in order to avoid dispersion and create a more focused magnetic field, thus obtaining a greater sensitivity to high frequencies and reducing the loss of highs due to the numerous turns in the coils. In other models, such as the Humbucker From Hell, DiMarzio used the same kind of polepieces with different windings to get a timbre closer to that of Fender-style single coils, but in a humbucker format.
Bill Lawrence seemed to favour a single blade polepiece, thought to transfer a more uniform magnetic flux and to give a cleaner sound.
Barney Kessel and other musicians used to prefer the Charlie Christian pickup over the P 90 because they thought that the blade pole gave a cleaner tone than the screw type.

Gretsch, on the Super'Tron 1, chose several thin blades as poles, which was similar to that used on a transformer core, thus creating the most efficient and perfect method in obtaining the clear tone sought after by country musicians.



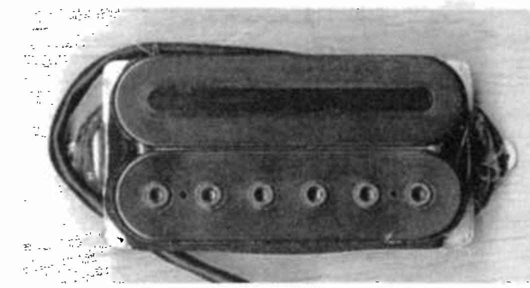
The Italian EKO used a similar method, but chose to use small blades under each string, in a single coil model, creating a pickup with good output level and a bright sound. Unfortunately this was not appreciated due to the poor quality of the guitars on which it was used.
Carvin used eleven polepieces in each bobbin for evenness of flux.

The Italian Red Push put twelve alnico cylindrical magnets in each bobbin, a diagonal pair under each string in single coil and humbucking models, to produce a wider magnetic field than on traditional Fender style pickups (in the humbucking a quicker attack is obtained).

As far as string spacing is concerned, guitars are all different. The main difference is apparent between the Gibson and the Fender standards. On Gibson-style guitars the spacing is narrower than on Fender-style guitars, for this reason pickup makers, whose humbucking models follow the Gibson standard for pole spacing, also offer versions with a Fender-style spacing for a better fit when mounted on that particular style of guitar.

Seymour Duncan designed the Trembucker series specifically for vibrato equipped guitars, following the Fender standard, with two rectangular polepieces under each string. The magnet can be Alnico or ceramic according to the model. The series includes also a model with stacked coils and dimensions similar to a Fender-style single coil.

Duncan offers several of the standard models in Fender-style spacing, described in the catalogue as "Trembucker spacing" versions. DiMarzio makes most models in the optional "F" version, which stands for Fender-style.



DiMarzio Megadrive

On some humbuckings different polepieces were used in each bobbin, so as to obtain the best characteristics of both, such as on the Duncan Screamin' Demon, with screw poles in one, Allen screws in the other.

DiMarzio used to make the Megadrive, with six Allen screws and a large blade, that model is no more produced, but the system is used again in the recently issued Dropsonic. The shape and the dimensions of the polepieces or magnets used could affect not only the magnetic field, but also the inductance.

No system is better than the other, it depends on the design and the sound sought after.

The important thing is that the polepieces must be made from ferrous materials, otherwise the magnetic flux is not transferred properly.

Other materials, such as brass, cannot transfer the magnetic field toward the strings.