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Vintage Fender Guitar Pickup Spec Info

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Introduction.

Ok, I admit i'm not an electrical engineer. But I get asked about vintage Fender guitar pickups quite often, so here's some info in case you're curious. Most of this information is from Seymour Duncan.

Terminology

- **Single Coil Pickup:** All *vintage* Fender pickups are single coil units. This compares to Gibson, which started using double coil (Humbucking) pickups in 1957. Single coil pickups have a single slab of wound wire around magnet(s). Single coil pickups are easily influenced by outside noise. This would include 60 cycle hum and fluorescent lights.
- **Humbucking pickup:** This type of pickup has *two* single coils combined into one unit. Each coil is reverse wound so that the hum from first coil cancels the hum from the second. The two coils are wired in series so the total resistance is additive, hence producing a "hotter" and quieter pickup (if the two coils were wired in parallel, the total resistance is half the sum of the resistances of each individual coil, assuming both coils are about the same resistance). In either case (parallel or series), the hum does cancel, hence the name "Humbucking". Note the difference bewteen parallel and series wiring of pickups/coils. Parallel is why the "in-between" setting used on a Stratocaster (combining the middle pickup with the neck or bridge pickup), *does not* produce a Humbucking pickup sound. Also, the in-between switch setting on a Humbucking two pickup Gibson is less powerful than each pickup individually. The two Humbucking pickups are combined in parallel (even though the two coils of each pickup are in series), thus giving the average of the two pickups divided by two. Interesting, huh?
- **Ohms:** messure of resistance. The longer the pickup wire and more turns used, the higher the resistance. Also the higher the resistance, the louder or "hotter" the pickup. But be aware, higher resistance comes at a cost: lose of treble frequencies. This is why single coil pickups have more treble and less output than Humbucking pickups (which use two coils). Hence Humbucking pickups have more mid-range and are "hotter". Also this is why single coil pickups that are wound with tons of wire (to approach Humbucking ohms) don't sound very good.

- **Turns or Windings:** this is the number of turns of wire used on the pickup. Fender had a mechanical counter attached to their winding machines that counted the turns. These vintage pickup winding machines were manually run by humans, so the exact number of turns can vary from pickup to pickup.
- **Winding Direction (WD):** This is the direction in which the pickup was wound. Seymour Duncan's terminology best describes this: TL means the top of the pickup bobbin is facing left. TR means the top of the pickup bobbin is facing right. TG means the top of the bobbin is turning away from the winder. TC means the top of the bobbin is turn towards the winder. Reversing the winding on a pickup will reverse the phase of the pickup.
- **Magnetic Polarity (MP):** This is the magnetic polarity on the top side of the pickup. All magnets have two poles: north and south. Reversing the poles of a pickup will also reverse the phase of the pickup. Note vintage Fender pickup magnets are the Alnico type, consisting of Aluminum, Nickel and Cobalt. They are "sand cast", and hence have a crude, rough look with pitting left from the sand cast. The tops of the magnets are ground flat. Usually the magnets have one end chamfered, which helps guide the magnet thru the vulcanized fibre flatwork (this is very noticible on Strats, and non-existant on pre-1955 Teles). Pre-1965 magnets are inconsistent in diameter, ranging from .185 to .197". But for the most part, they fit very tightly in the flatwork. Starting in 1965, the diameter seemed to get narrower by a few thousands of an inch. Hence the flatwork did not fit as tightly around the magnets. This causes many 1965 and later Fender pickups to "warp", where the flatwork will actually buckle and curve. Mid-1960's magnets have a smoother edge, and eventually the chamfering of the pickups stopped entirely by the early 1970's.
- **Flat Work:** this is the vulcanized fibre portion of Fender pickups. This material holds the magnets in place (and the windings of the pickups then go around the magnets). Pre-March 1964 Fender pickups used black vulcanized fibre flatwork. After approximately March 1964, this changed to a light gray vulcanized fibre. Then again in the early 1970's, it switched back to black vulcanized fibre.
- **Hand Winding:** This is also known as "scatter winding", where the pickup wire is wound on the bobbin in a random manor. This is how Fender pickups were wound prior to 1965, since it was a semi-manual operation, using a machine to turn the pickup bobbin, while a worker would guide the wire onto the turning bobbin. In 1965, Fender changed to "machine winding", as it is a completely automated process. Machine winding takes away much of the character of the pickup. A lot of the sound of old Fender pickups is due to the random layering and variable winding tension of the wire, which effects the tone. With machine winding, this is all very sterile and consistent. If you see the chart below, notice how consistent the Strat pickup specs get when machine wound (after 1964). Not much variance from year to year with

machine winding.

- **Insulation:** this is the surface coating that is baked on to the wire that prevents the turns of the pickup from shorting out. We are all familiar with the insulation on larger wire: usually it's a PVC plastic coating that you have to strip away when connecting. But on the extremely thin wire used in pickups, this insulation is a bake-on coating. There are several different type of baked-on insulation: Formvar, Plain Enamel, or Poly. Fender used Formvar till about March 1964, when they switched to Plain Enamel. This happened at about the same time they switched from black flatwork to light gray flatwork.
- **Wire Outside Diameter (OD):** this is the outside diameter of the winding wire, not including the insulation. The thinner the wire, the higher the resistance (ohms). Though this has less of an effect on resistance compared to the number of windings.
- **Wire Gauge**: this is the gauge of wire as advertised by the wire manufacturer. Fender basically used 42 gauge wire for everything but the Telecaster neck pickup (43 gauge). Note the actually outside diameter (OD) varies slightly even though it's the same gauge. As the gauge number increases, the OD of the wire decreases (42 gauge wire is thicker than 43 gauge wire).
- **Potting**: dipping a pickup in wax to seal the windings to minimize vibration so the pickup feedbacks less (and is not "microphonic").

Why do Vintage Fender Pickups Sound so Good?

There are probably a lot of little factors that make the older Fender pickups sound so good. Not a single one of these factors will change the tone significantly. But when all added together, the sum of the parts is better on older vintage Fender pickups. These factors would include:

- **Magnets:** pre-1965 Fender pickups used larger diameter magnets and were sand casted. Also vintage Fender magnets are Alnico and not Ceramic. Finally, as time goes on older magnets lose some of their power. The less power the magnets have, the better the strings can vibrate. Powerful magnets can actually pull the strings towards the pickup, dampering the vibrations. So there needs to be a balance, because you don't want too strong or too weak magnets. So maybe after 30 years, the magnets are at their "ideal" power, thus producing "ideal" tone. Another thing that is different is the "stagger" pattern. That is, the height of the individual magnet pole pieces. For example, today no one uses a wound third (G) string. But prior to Hendrix, most players did. To compensate for this, the fixed magnet heights were different on older Fender pickups.
- **Windings:** handwound pickups (like pre-1965 Fenders) seem to sound better. It's hard to say why, but the scatter-winding pattern and tension at which the wire was wound was apparently ideal on pre-1965 Fender pickups.

The handwinding tonal difference may be due to a lack of distributed capacitance when scatter-wound.

- **Wire Insulation:** the insulation on the windings of vintage Fender pickups have different chemical composition than newer wire. Even though the gauge of the actual wire is the same, the thickness and composition of the insulation is different. This changes the total size of the wound windings. This in turn changes the inductance and capacitance of the pickup, and hence the tone. Fender used Formvar insulation till about March 1964. Then they switched to Plain Enamel insulation.
- **Pots:** the older potentiometers used have wider tolerences than newer pots. This may sound dumb, but it could change the tone slightly.
- **the Guitar itself:** older instruments have older and harder finishes. And they also used nitrocellulose finishes that were applied very thin. Also the wood itself is older and different than wood today (less polution back then means "cleaner" wood). This will also effect tone.
- **Time:** even if all the above are paid attention to and duplicated, time is something that just can't be made up for. Maybe they sound better because they are just older...

Why do Vintage Fender Pickups Die?

After many years of use, Fender pickups die much more regularly than any other brand of pickups. Even Gibson pickups from the 1930's don't die like Fender pickups from the 1950's. Actually, the reason has to do with the design and materials of Fender pickups themselves.

Since the windings of older Fender pickups are in direct contact with the magnets, this has caused some problems. With time, the magnets seem to chemically react with the windings/insulation, causing the windings to break. Once a single inner-most layer of winding is broken, that's it; the pickup is "dead". Due to magnetic fields, the pickups may still work, but it will sound *extremely* thin and weak. Also, if you turn down the Tone control to that pickup, it will go complete dead and silient. That is a sure test of a dead Fender pickup. You can also measure the Ohms of the pickup. Dead pickups will register "open" (no resistance). But because the pots are in-circuit, an open pickup may read some bizarre high resistance, and the value may bounce up and down (again, due to the magnet properties of coils and the pots in the circuit). You should do the Ohm test right at the pickup leads, and to do it right, have one lead disconnected from the circuit (but please don't desolder any vintage guitar pickup leads!) Also the position of the pickup switch can effect values too, as can your fingers if they are touching the meter's probes. Just keep that in mind.

Another thing that kills old Fender pickups is someone trying to "adjust" the (non-adjustable) pole pieces (magnets). Because of the lack of a wound third (G) sting, some musicians push the G string magnet down through the flatwork, moving it further away from the strings. The problem is this can tear the inner windings. Since the magnets are in direct contact with the windings, and the magnets are sand casted and have rough sides, this will easily tear a winding. One torn winding will create a dead pickup (see the paragraph above).

Newer Fender pickups have been able to avoid both of these problems. Now, after the magnets are installed in the flatwork, lacquer is sprayed over the magnets and flatwork. Then the wire is wound around the magnets. This means the magnets are no longer in direct contact with the inner windings. Therefore, if the magnets are pushed thru the flatwork, they are less likely to tear the windings. Also there is less chance of a chemical reaction between the magnets and windings as they are insulated from each other by the lacquer.

Vintage Fender Pickup Specs.

These specs are thanks to Seymour Duncan. He does excellent vintage reissue Fender pickups and Fender rewinds. Unfortunately, he's too busy to do rewinds much any more - too bad for us all. He used to **fix** dead Fender pickups by unwinding the original wire, fixing the internal break, and re-winding the original wire back on the pickup! But this is very time consuming, so don't even bother asking him to do it now, as he's very busy (he'd keep busy for a long time just fixing all my dead Fender pickups alone!).

The following table shows Stratocaster pickup specs from 1954 to 1967. Seymour got this data from the thousands of Strat pickups he has fixed or rewound. He then averaged the data together by year, and came up with this table. Note the magnet polarity was changed in 1960 (even though Seymour thought it was 1958, other data suggests it's more like 1959/1960).

1954 to 1967 Fender Stratocaster Pickup Specs

Year	Ohms	Wire OD	Insulation	Turns	WD	MP	Wound
1954	5.76k	.0030"	Formvar	7956	TL/TG	North	Hand
1955	5.89k	.0029"	Formvar	7844	TL/TG	North	Hand
1956	5.98k	.0029"	Formvar	8012	TL/TG	North	Hand
1957	6.02k	.0029"	Formvar	8105	TL/TG	North	Hand

1958	6.20k	.0028"	Formvar	8350	TL/TG	North	Hand
1959	5.95k	.0030"	Formvar	7925	TL/TG	North	Hand
1960	6.33k	.0028"	Formvar	8293	TL/TG	South	Hand
1961	6.19k	.0029"	Formvar	8119	TL/TG	South	Hand
1962	6.22k	.0028"	Formvar	8220	TL/TG	South	Hand
1963	6.37k	.0028"	Formvar	8319	TL/TG	South	Hand
1964	6.25k	.0027"	Formvar/Enamel	7980	TL/TG	South	Hand
January 4, 1965, CBS bought Fender Musical Instruments.							
1965	5.80k	.0026"	Plain Enamel	7626	TL/TG	South	Machine
1966	5.76k	.0026"	Plain Enamel	7630	TL/TG	South	Machine
1967	5.88k	.0027"	Plain Enamel	7656	TL/TG	South	Machine
Year	**Ohms**	**Wire OD**	**Insulation**	**Turns**	**WD**	**MP**	**Wound**

The following table shows the difference in pickups by Fender model. Wire specs (gauge, insulation) are for the earliest models produced. Again, this is an average of data from Seymour Duncan.

Fender Pickup Specs by Model

Model	Wire Gauge	Insulation	Avg. Turns
1000 Pedal Steel	42	Formvar	8000
400 Pedal Steel	42	Formvar	8000
5 String Bass	42	Plain Enamel	12,000
Bass VI	42	Formvar	8550
Deluxe 6 LapSteel	42	Formvar	8350
Deluxe 8 LapSteel	42	Formvar	8550
Dual 6 Steel	42	Formvar	8350
DuoSonic	42	Formvar	8350
Electric 12	42	Plain Enamel	12,500
Electric Mandolin	42	Formvar	8000

Jaguar	42	Formvar	8550
Jazz Bass	42	Formvar	9000
JazzMaster	42	Formvar	8500
Mustang	42	Formvar	7600
Precision Bass	42	Formvar	10,000
Stratocaster	42	Formvar	8350
Telecaster (lead pu)	42	Formvar	8000
Telecaster (neck pu)	43	Formvar	8000
Model	**Wire Gauge**	**Insulation**	**Avg. Turns**

Potting a Pickup.

If you are having problems with a pickup being "microphonic" or feedbacking, sometimes you can fix this. WARNING: be careful! you can ruin a perfectly good pickup trying to pot it. For this reason, I recommend letting a professional do this for you.

Anything that can vibrate on a pickup can cause feedback: the covers, loose boobins, a loosely wound coil, a loose baseplate (Tele pickups), loose magnets, etc. Humbuckers with the covers can excessively feedback too, so you can pot them with the covers on to minimize feedback. The idea is to fill the space between the bobbins and the cover and secure everything in place.

In order for the wax to penetrate the coil, the entire pickup first has to be as hot as the wax's melting point. That takes time. As the wax penetrates the coil you will see air bubbles coming out of the pickup. It is not saturated until the bubbling stops, which can take 2 to 10 minutes. The tape around the coils does not need to be removed, the wax will get in just fine. It is absolutely crucial to monitor the wax temperature and keep it below 140 degrees or else the bobbins will melt and distort, killing the pickup. A special blend of parafin and beeswax guarantees a low melting point. Wax that is heated too much without temperature monitoring can spontaneously combust like fuel. This is very dangerous. DO NOT PUT IT IN THE MICROWAVE. A "double boiler" is the best way to heat wax. This involves putting the wax in a container, and then putting that container in a pot of hot water. The Water is heated directly by the heat source, not the wax container.

If you only have one or two pickups to pot, buying the wax will cost you more

than having the job done professionally.

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