
Humbucking Pickups - How They Work

We should first explain two properties of pickups which were never previously discussed -

magnetic polarity and *coil windings*.

Two pickups can be combined with these two properties in four ways:

*****	Magnetic Polarity	Coil Windings	Output	Hum Canceling
1)	Same	Same	Strong	No
2)	Opposite	Opposite	Strong	Yes
3)	Same	Opposite	Weak	Yes
4)	Opposite	Same	Weak	No

The rightmost columns "Output" and "Hum Canceling" will be discussed later.

Combination number 1 is the way in which guitar pickups have been manufactured and installed ever since the very first electric guitar. This was (and still is), a pretty good way to wire guitars with the only problem being hum.

Guitar pickups are wound with a *lot* of wire which unintentionally creates an "antenna" which can "receive" electromagnetic interference from fluorescent lights, light dimmers, electronics equipment and *especially* 60 cycle AC hum. Generally, guitar players have learned to live with this interference by avoiding playing near electrical equipment and by facing in a direction in which the guitar produces the least noise.

Humbucking Pickups

Combination 2

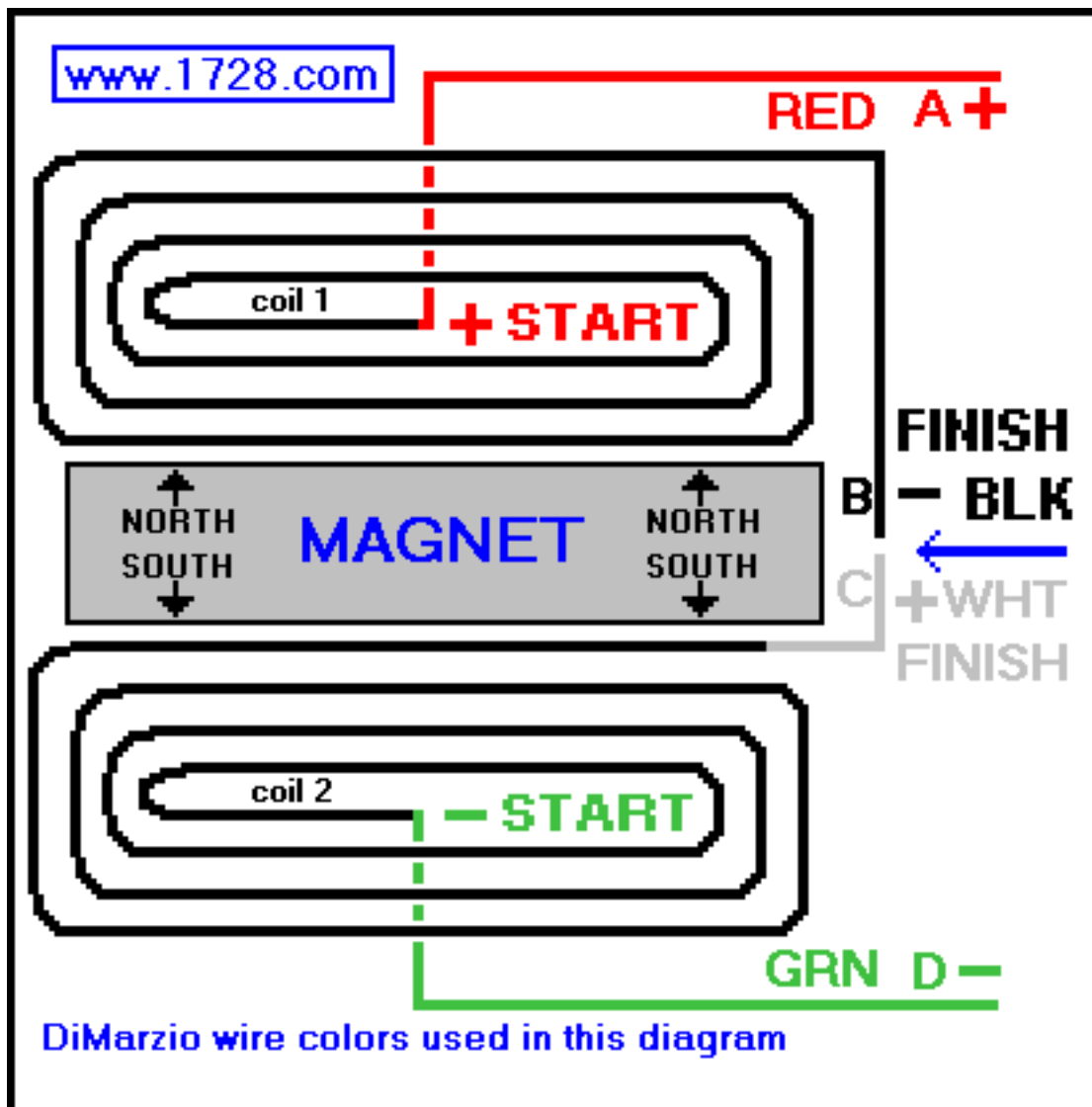
Opposite Magnetic Polarity Opposite Coil Windings

Probably the most successful attempt in reducing pickup noise was in 1955 when Gibson Guitar employee Seth Lover developed the humbucking pickup. These pickups are actually *two* side by side, single coil pickups with each coil differing from the other by

having *reverse winding* and *reverse magnetic polarity* (abbreviated as "RWRP"). Humbucking pickups can have more than one magnet, but to keep things simple, let's see how a single magnet humbucker works.

Did you notice that the magnet in the drawing has its polarity on its *edges* instead of on its *ends*? This is done to keep the magnetic strength constant from one end of the magnet to the other permitting all 6 guitar strings to have the same volume.

The other reason for polarizing the edges is to allow *both* coils to have **opposite magnetic polarities** which the diagram below easily demonstrates.



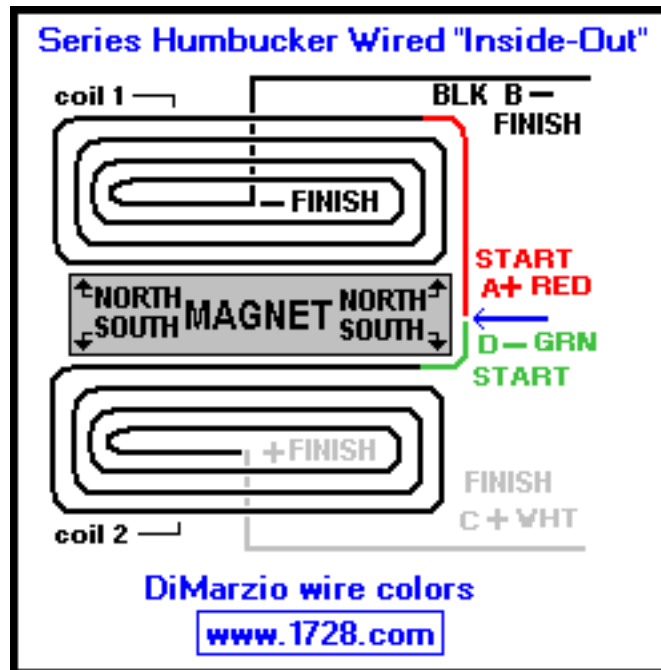
Moving on to the coils, both are shown with *windings* going in a *clockwise* direction. However, shouldn't those coil windings be the *reverse* of each other? Not exactly. Basically the term "reverse winding", although it is used by just about everybody, is inaccurate. Actually, it is the *current flow* in the two coils that travel in *opposite directions*.

In the diagram, the current begins at the center of coil 1 then travels *clockwise* until it reaches the *series connection* (the place where the two coils join - indicated by the blue arrow). The current enters coil 2 at point C and if we follow it to point D, we see that the current has traveled in a *counter-clockwise* direction. *This is what makes humbucking pickups work the way they do.* Coil 1 and coil 2 are *electrically* out of phase and since electrical interference only travels through the guitar pickup's windings, when the hum travels from one coil to the other, it gets canceled due to the opposite coil windings. (The magnets play no part in hum cancelation.)

Unlike hum, an electric guitar's sound (the signal) is generated from the pickup's *wiring and magnets*. So, when the guitar signal travels through the coils, no cancelation occurs because the coils are out of phase electrically *and* magnetically.

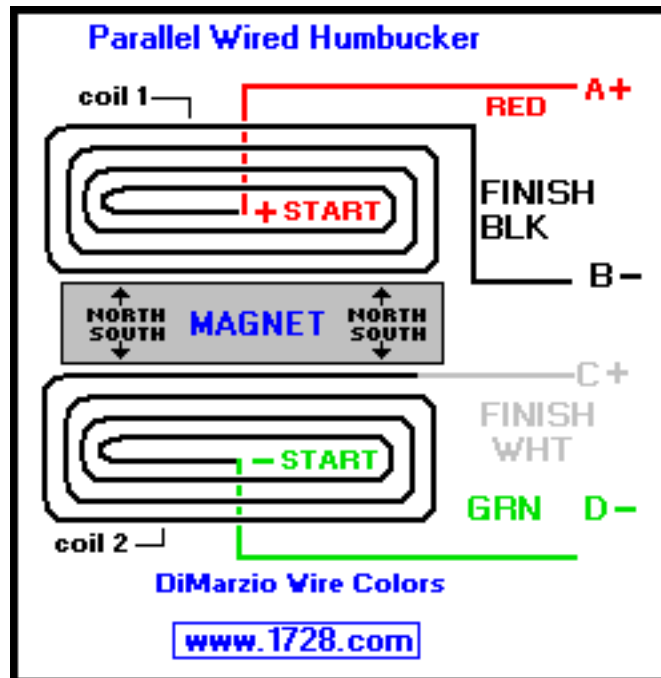
In effect, having opposite electrical *and* magnetic polarities is similar to putting two phase switches on two pickups. When both switches are set to the out of phase positions, no cancelations occur because the 2 "out of phase" conditions cancel each other out.

Anyway, if you just wanted to learn how humbucking pickups work, you don't have to read any further. However, you might find it interesting to continue.



The above graphic shows a humbucking pickup wired in series and connected in what I call an "inside-out" wiring. The wires that were joined at the series connection are now on the "outside" of the pickup and the 'A' and 'D' wires now meet at the series connection. But is this humbucking? Well, both coils have opposite magnetic polarity and just as in the previous example, when the current in coil 1 travels in a clockwise direction, it travels *counter-clockwise* in coil 2. Since we have opposite magnetic polarity *and* opposite coil windings (actually current flow), this is just as valid as if it were wired in the conventional way.

Why would we want to wire it in this way? Among other things, it is something to consider when you choose to add coil cut switching to the wiring.



The above graphic shows a humbucking pickup wired in parallel.

The important features of parallel wiring are:

- it produces a brighter sound than series wiring *and*
- it is humbucking.

In this wiring, the 'A' and 'C' wires are connected to '+' and to each other. The 'A' wire begins at the "**START**" in coil 1, and travels clockwise. The 'C' wire begins at the "FINISH" of coil 2 and travels in a counter-clockwise direction.

The 'B' and 'D' wires are also connected and if we follow those wires, 'B' enters coil 1 in a counter-clockwise direction and 'D' goes from the center of coil 2 in a clockwise direction.

So, as we can see, in both cases we have a reverse current flow and since we have opposite magnetic polarities, this is a properly wired humbucking circuit.

Even the Fender Guitar Company started making their guitars humbucking, but not with traditional humbucking pickups. Before the mid 1980's, if you had a single coil guitar, *all* its pickups had the same magnetic properties and *all* were connected so that the current flow in each was exactly the same. By now, you should know why this does *not* produce a hum-canceling circuit. (remember combination 1?)

Then, around 1985, the Fender Guitar Company thought of an easy and inexpensive way to solve the hum problem by making the

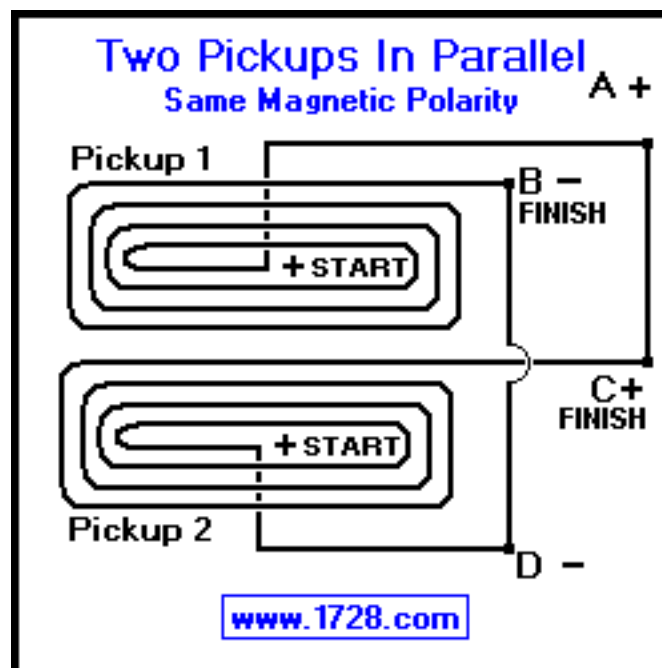
middle pickup in a Fender Stratocaster™ have reverse wiring and reverse polarity of the other 2 coils. This in effect "created" a humbucking pickup whenever someone selected two pickup combinations - neck and middle or middle and bridge.

Still, this left the neck and bridge pair in a non-hum-canceling status, which didn't bother too many people because the "neck and bridge" choice is not available for a standard Fender Stratocaster™.

Combination 3

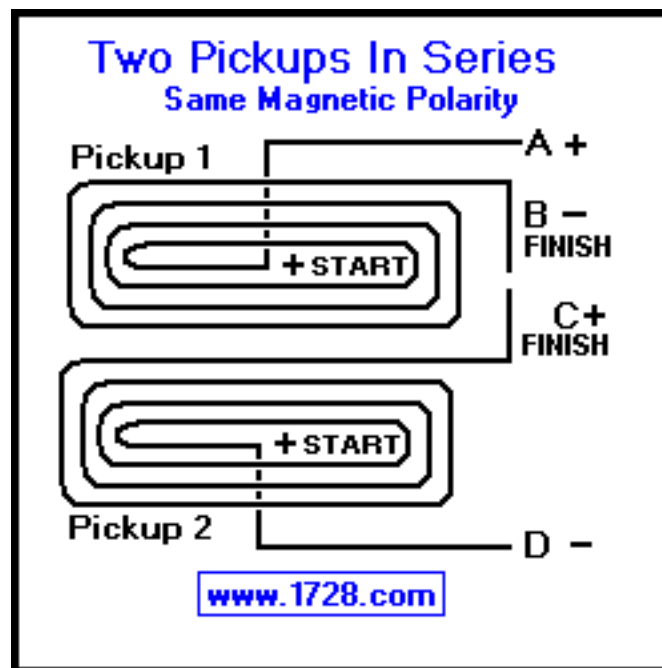
Same Magnetic Polarity Opposite Coil Windings

Since humbucking pickups always have two coils with *opposite* magnetic polarities when would we be connecting two pickups with *similar* magnetic polarities? How about when connecting the neck and bridge pickups of a Fender Stratocaster™?



Looking at the diagram we see that connecting A to C and B to D (the typical parallel wiring method) creates a circuit in which the current flows through the coils in opposite directions, ensuring the

hum *will* get canceled. However, we also need (but don't have) opposite magnetic polarities to counteract the *electrical* out of phase guitar signal. Basically, we have a circuit in which the hum *and* the guitar signal gets canceled. The guitar signal doesn't get 100% canceled (just as the hum doesn't get 100 % canceled either) and so the guitar signal has been reduced to a weak, thin, squawky "out of phase" sound. Actually, some people like this sound. It is used quite often in country music and produces a penetrating sound when used through distortion. It is not a sound you would want to have all the time but that's why there are switches on guitars.



The above graphic shows a series wiring of this humbucking circuit. This one, due to its greater volume is more popular than a parallel out of phase circuit.

Combination 4

Opposite Magnetic Polarity Same Coil Windings

Of all four combinations, this is undoubtedly the worst of the bunch. It produces a weak guitar signal that isn't even hum canceling.

If you wired a humbucking pickup out of phase, this is the result. You've probably seen books and other websites that state that this produces a poor sound because the coils of a humbucking pickup are so close to each other. No, I believe the problem is the lack of hum canceling and the rather weak guitar signal. Together, these produce a very poor signal to noise ratio.

Our recommendation is not to try this combination at all, whether in a humbucking pickup or two separate pickups.

Well, now that you have become a humbucking "scholar", maybe your next guitar project will not seem so overwhelming.

[Return To Guitar Wiring Page 1](#)

[Return To Home Page](#)

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