Les Paul's inventions and innovations

Les Paul, the only person inducted into both the Rock and Roll Hall of Fame and the National Inventors Hall of Fame, often relayed that he may have spent more time inventing than he spent performing. But, his passion was performing. He invented things when he needed something that was not yet available. He invented to create his unique sounds. The many recording techniques he developed in his Hollywood garage and later in his Mahwah, New Jersey home studios forever changed modern music.

Les' first invention: Flip-able harmonica holder – Harmonica holders were available in the 1920s, but they held the harmonica in one position. When he was around 13 years old, Les was playing his guitar and harmonica in public. He wanted to be able to play both sides of his harmonica in order to change keys without putting his guitar down, so he invented a flip-able harmonica holder from metal coat hangers and a piece of wood. His design has evolved into a readily available product.

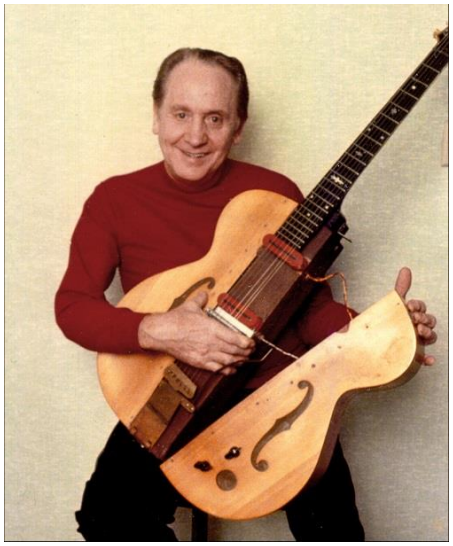
Solid Body Electric Guitar – Les Paul is synonymous with the solid body electric guitar he pioneered and that bears his name. The evolution of the design began when Lester was a teen performer in Waukesha, Wisconsin. In the early 1930s, when Lester created his first electric guitar when he took the arm of his mother's phonograph, jammed the needle into the top of his acoustic guitar, taped the arm to his guitar and connected it through his father's radio.

The Rail was primitive, but it proved that he could get the guitar string to vibrate and create a clear sound that had tremendous sustain. This early experiment happened in the early 1930s, ten years before Les' experiments with his Log.

The Log – **Les' first solid body electric guitar** - While working in New York City, Les obtained access to Epiphone's factory on Sundays so that he could use their machines as he continued to invent. The wonderful sound he had created with his Rail haunted him. Although transporting a piece of train rail was impractical, he was determined to find a way to recreate the sound he had found with the Rail. Here is how Les described it in *Les Paul In His Own Words*:

> "… in 1941 as I continued my efforts to create an electrically amplified guitar whose acoustical properties didn't cause feedback. I was looking for volume, tone and sustain that could be controlled, still chasing the idea that started with stretching a guitar string over a section of railroad rail. The thing that grabbed me about that early experiment was how the string vibrated and sustained almost indefinitely when anchored to the solidity of the steel rail, with no feedback whatsoever.
>
> "…for the electric guitar, the solidity of the neck and body and the way the strings attach were the critical factors I needed to pursue. … what I needed to do was put the railroad rail into the guitar.

I took a length of 4 x 4 pine, put an Epiphone neck on it, wound a couple of homemade pickups and mounted them on the wood. Then I added a bridge and a Vibrola tailpiece, strung it up, and I had the Log. It was crude, but when I plugged it into an amp, it worked.

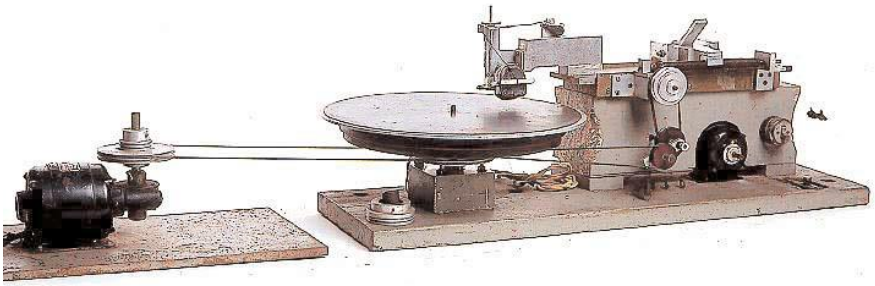


On a Saturday night, I took it to The Sheik, a little club in Sunnyside, where I played the same songs (on the Log) with the same trio I often jammed with, and nobody gave much notice to it. I was getting a very cool, unusual sound with this electric Log ... A piece of lumber being played as an electric guitar was something nobody had ever seen before, or even thought of, but it didn't seem to make a big impression.

So I went back to the Epiphone factory, took the sound box of an old Epiphone archtop, and sawed it in half right down the middle. Then I braced up the halves so they could be attached to the sides… With wings attached, I took the Log back to the same club, and jammed again with the same trio. And to my surprise, there was a great reaction. Everyone started talking about the unusual sound and asking questions about the guitar and my amplifier. There was a positive reaction to the sound I got that night, which was the same sound the same people had heard before. So I came to the conclusion that people hear with their eyes." Page 103

Recording innovations

The lathe – Teenage Les Paul, then known as Lester Polsfuss and Red Hot Red, began experimenting with recording his music. Young Lester wanted to hear what his audience heard.



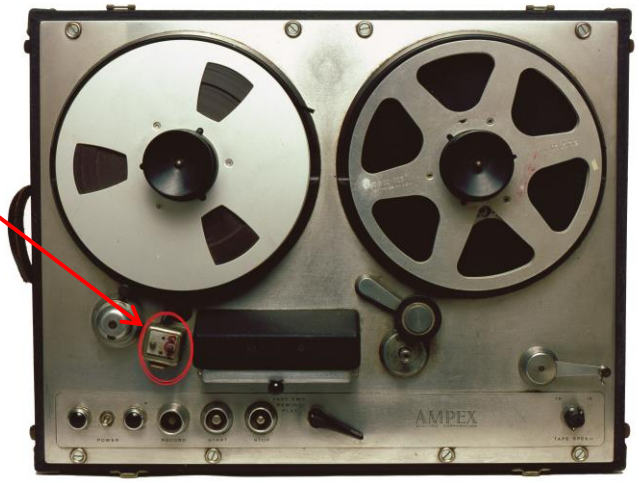
One of his earliest project was creating a recording lathe so his mother could record his radio performances. The lathe had a discarded Cadillac flywheel, a dentist's continuous belt and a paring knife from the family's kitchen. The lathe recorded by cutting a groove into a disc of aluminum. Although crude in design, it worked.

Sound on Sound – Even before creating sound on sound with discs, young Lester did his very first over-dubbing when he punched extra holes in his mother's player piano roll, then taped over the holes he did not want.

In the mid-1940s, 30-year-old Les and his friends began to develop the idea of sound on sound for commercial quality multi-track recording. Les recorded his first track of a song on a disc. Then he performed a second track as he played back the first track. He recorded both layers together on a second machine. If he was not satisfied with the recording, he discarded the disc and started over. When he got the recording he wanted, Les would move the two-layered disc to the playback machine and repeat the process with a third and subsequent discs.

Les used an equalizer in order to "extend" the range of each recording. If he wanted a certain track (especially one of the first few he laid down) to have more bass, treble or mid-range, he would boost that particular level so that by the time all of the other tracks were laid down, the

first few wouldn't get lost. The fidelity of these recordings was almost as impressive as the sound on sound technology. People couldn't believe how great his records sounded compared to the other recordings of the time.



Shortly after Les received one of the first tape players from his friend Bing Crosby, he added an additional playback head before the recording head so that he could produce on tape the sound on sound effect he had been doing on discs. This is the machine Les used to create his recordings with his wife Mary Ford.

Les described it this way in *Les Paul in His Own Words*:

> " ... (I) began to realize that I could use the tape recorder to do what I was doing with the two disk cutters if I could figure out how to do sound on sound on tape. And that's when it hit me. I grabbed a piece of paper and wrote down the idea that was suddenly there in my head, and it was like God had done it. The idea just flashed into my mind that the way to do it was to add a fourth head on the machine, and I immediately drew out a rough design for doing it.
>
> ...It means all the stuff we've been confined to doing on two disk recorders, we can now do on one tape machine!' I was talking about what it took to produce our radio show, multi-layering tracks with the disk recorders like I'd done on *Lover* and *Caravan* and *Nola*. I was talking about the first sound-on-sound on tape, which led to the first true multi-track recordings and the eight-track machine Ampex later built for me."
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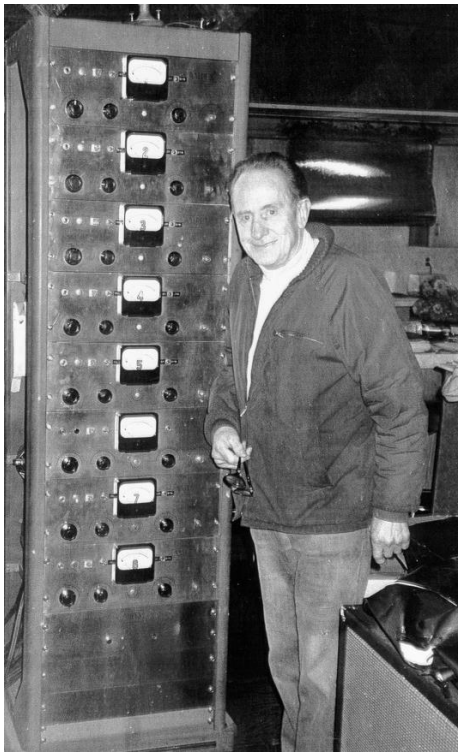


The Octopus – Les realized that although recording to tape gave him the sound he was seeking, it also eliminated the ability to go back one step as he did with the two-disc system. After creating many hit songs using the sound on sound method with the early Ampex recorder, Les decided that to record each layer separately and then combine the sounds would allow the flexibility to change one layer without destroying the others. Les contracted with Ampex to build his idea. It took years of refinement, but the invention gave recording artists tremendous flexibility.

Les shares his inspiration on creating the 8-track in *Les Paul in His Own Words*:

> "Working with film audio (in the TV show "Les Paul and Mary Ford at Home") inspired me to want to build an eight-track recording machine where the heads were all evenly aligned.... We'd had multiple heads before, but there were limitations because they were always staggered, so you couldn't edit or do stacked multiples where each track was independent of the others. And my invention was to stack the

heads one on top of the other so they were all aligned in the same place, and you could use the same multiple head for recording and playback, and everything would be in sync." Page 284 - 288

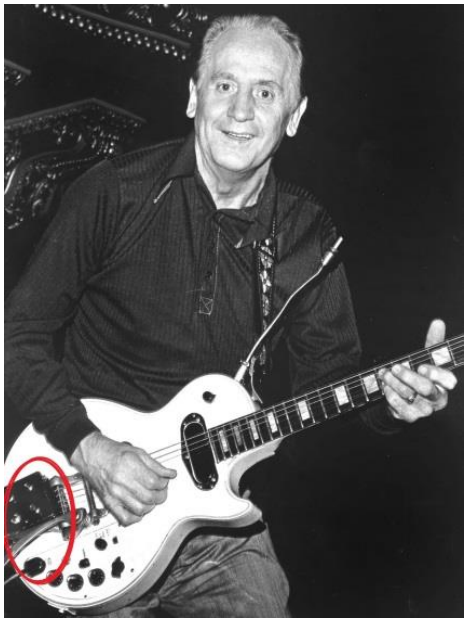
When comedian/actor W.C. Fields heard Les' sound on sound recordings he said Les sounded like an "octopus". Les transferred the name to his 8-track recorder.

Phase shifting happens when two identical audio signals are played at slightly different times. One signal plays very slightly slower or faster than the other. As they repeat, they will be "in sync" for a brief period of time, then shift "out of phase". Les made a variety of "whooshing" sounds on his recordings by using phase shifting. You can hear it in Les' recording of "How High the Moon."

Close miking – In the 1940s when Les' career was gaining steam, performers were using very large microphones set in the middle of the room. Les did not want the room's ambient sound. He wanted to hear just the musical instrument or the singer so he moved the microphone closer to the singer and adjusted the mechanics accordingly. Les realized that not only the distance to the mic was important but also choosing the right recording environment to create the sound he was seeking even before the actual recording. Note how close the mic is to singer Jimmy Atkins in this photo of Les Paul with his klunker and Ernie Newton on bass.

Delay – As Les was experimenting with sound on sound on his Ampex tape recorder he observed, "Something I discovered in that learning process was the delay effect and the way it could enhance sustain and the fullness of the tone." Les developed several variations of delay.

- **Echo** is a repeat of a sound after the original has ended, similar to a canyon echo: HELLO – hello – hello.



- **Reverb** is a repeat of a sound while the original is still playing. The delay is too short to be perceived as an individual repetition. It is similar to the sound you hear when singing in a large bathroom.

- **Slap Back**, a single repeat (echo) of the original sound, was something Les used in many of his recordings. You can hear it on "Little Rock Getaway."

Variable Speed or Varispeed changes the pitch of a sound and is similar to slowing down or speeding up a turntable. Les recorded sounds at half speed, then played them back at full speed, resulting in a higher pitch. This effect can be heard in "Lover" and "How High the Moon."

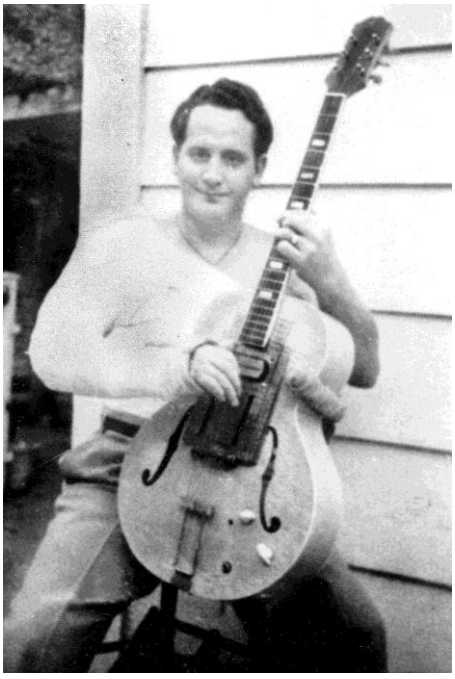
Les Paulverizer – What started as a gag to explain sound on sound in a non-technical way to his radio audience evolved into an onstage piece of showmanship. Les told his radio audience that his magic box, "the Les Paulverizer," multiplied his guitar playing and Mary's

singing. When Les Paul and Mary Ford performed on stage, their fans wanted to hear their favorite multi-track songs. Les created a box of switches that allowed him access to pre-recorded tapes of layers of their songs, allowing him and Mary to present their multiple layers at live performances. Les attached the box to his guitar for ease of access.

Headless guitar – Les was always altering his guitars. Trying to reach into the guitar was a constant challenge. His "Klunker" guitars had trap doors in the back, but Les was looking for something even better. In fact, he tried several unique characteristics in his headless guitar.

Les describes it in *Les Paul In His Own Words*: "Using sheet aluminum and an old neck, I built an electric guitar with the tuning gears below the bridge instead of up on the headstock. There was no headstock on this guitar, just the nut at the end of the neck where the strings were anchored. The guitar was very light, with a removable back so it was easy to work with, but there was a problem. (When on stage) The aluminum was so responsive to the hot lights it was knocking the guitar out of tune every time. So that was the end of using the aluminum guitar on stage... I did use the aluminum guitar occasionally for recording because it had a unique sound." Page 172

Capitol Records Echo Chambers – In the 1950s, Les Paul working as a consultant, provided direction on Capitol Records' network of eight echo chambers that are located under Capitol's parking lot as well as the sound studios.



According to building designer Lou Naidorf, Les Paul was the primary musician who evaluated and approved the designs of the echo chambers and the studios. While most of Les' original inventions, "inspired" current technology, the echo chambers continue to be used every day by today's top recording artists.

Guitar holder -- Les was always creating things to meet the needs of the moment. After his infamous 1948 car accident, Les directed a friend on how to reshape a guitar stand to hold his guitar so he could play even when he was wearing the torso cast.

The **mini-guitars** – To prove that he could actually play the very high notes heard on his New Sound recordings, Les had Gibson make two small guitars so that when he was on stage he could pull out one of the mini guitars and play the very high notes. Only two were ever made.

Patents
Although Les was constantly inventing, he rarely bothered to patent his inventions. When asked, he responded that he was not interested in going through all the paperwork to obtain patents. He relayed that he created new things when he needed something that didn't exist and if someone else could use what he created, that was okay with him.

Les took out a few patents:

- Mar. 13, 1956 – Patent # 2,737,842 - "Combined Bridge and Tail Piece for Stringed Instruments."
- Jan. 30, 1962 – Patent # 3,018,680 - "Electrical Musical Instrument" which was Les' design of a single magnetic pickup for any stringed instrument.
- Apr. 3, 1973 – Patent # 3,725,561 - "Method of Electronically Reproducing Music and Improved Electrical Pickup for Practicing the Same" is an improved pickup for a drum.

Sound Diffuser wall – Another example of Les' constant inventiveness is his sound diffuser wall. He designed the shape of the individual pieces. Les and his son Russ cut, stained and adhered each piece to the walls in one of his Mahwah, NJ studios. The room was totally "neutral", just the way Les wanted it to be. Segments of the wall are on display in several museums.

Hearing Technology
A major irony in Les Paul's life is that the man who spent his life chasing sound had to wear two hearing aids and he wasn't satisfied with their quality. Up until his last days, Les was working on improving the technology of hearing aids.

Morel education resources: http://www.les-paul.com/timeline/les-the-inventor/
https://sites.google.com/a/dpi.wi.gov/les-paul-study-units/home

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SKB