

Fig. 1: Outsiders among electric guitars: “Gibson Les Paul Triumph Bass” and “Les Paul Recording”, 1971



What Are “Low Impedance” Pickups?

BY HELMUTH LEMME

Normal magnetic guitar and bass pickups have DC (direct current) resistances of about 5 to 20 kOhms, which can easily be measured with an ohm-

meter. But this reading does not say much about the tonal properties of the pickup. The more meaningful magnitude is *inductance*, measured in Henries. Most commercial pickups have inductances be-

tween 2 and 10 Henries. A low figure means a piercing, twangy sound; a high figure a warm, fat sound. An alternative to these were some pickups with extremely low DC resistance and inductance. What were they good for? They were especially developed for a series of guitars by Gibson in 1969, which were meant purely for studio use. According to Les Paul's wishes, these guitars could not be used with normal guitar amps but were designed to plug directly to standard mixer inputs which only had a low impedance input in those olden times as they were designed for dynamic microphones with 200 Ohms. Standard pickups were incompatible, as they didn't have the required inductance of only a few Millihenries (= 1/1000 Henry).

Around these pickups Les Paul developed some completely new instruments with unconventional controls. There were two guitars, the Les Paul Professional (with nickel plated hardware) and the Les Paul Personal (with gold plated hardware and a microphone on a flexible swan neck with its own volume control). There was also a bass, the Les Paul Professional with a short scale of 76 cm (30"). The bodies consisted completely of mahogany without maple tops, and the shape was similar to the well-known Les Paul guitars but a little broader. Most examples were dark-brown. There was also an acoustic flattop guitar with cutaway, called Les Paul Jumbo. The new pickups had broad, oval plastic covers with the Gibson logo on them. Inside they contained two coils on top of each other and were wound in reverse, so they probably were the first stacked humbuckers commercially produced. Despite the fact the original idea for this was first discovered by Armand Knoblauch in 1938. In the Gibson guitars they are mounted slanted, Fender style.

The controls are unconventional. There is a toggle switch for pickup selection, one volume control, one treble and one bass control, a 'PHASE' slide switch, and an 11-position rotary switch called 'DECADE' (except in the bass). There is also another 3-position toggle switch called 'TONE', to activate/deac-

tivate the treble and bass controls. The pots and the DECADE switch are mounted from the rear side into the body, the TONE and PHASE switched are mounted on a small oval black plastic plate in the top. The acoustic guitar had only one pickup.

Gibson also offered a special amplifier called 'Les Paul LP12' with low and high impedance inputs. In order to connect to normal amplifiers the guitars included a small transformer, built into the cable. However, even with this the output voltage was much smaller than with a normal humbucker. That was of course no concern for Les Paul, he rarely played with overdrive, staying on the clean side of sounds. None of these instruments enjoyed any great success. According to Tom Wheeler's book *American Guitars*, Gibson built only 931 Professionals, 148 Personals, and 49 Jumbos.

In 1971 Gibson replaced them with new versions. The 'Les Paul Recording' and the 'Les Paul Triumph Bass' (**fig. 1-** on previous page). Here the entire electrical wiring is installed from the front side, mounted on a large black plastic plate. The body is nearly the same size as a normal Les Paul. This instruments have a bevel on the back, for a more comfortable playing position. Most examples have a natural mahogany finish, with some others being white, black and occasionally red. A transformer to facilitate plugging into a normal guitar amps is built-in and can be activated with a second slide switch called 'OUTPUT HI / LO'. Les Paul himself played a lot of different units of these guitars, including special models with straight aligned pickups and a remote control for a tape recorder.

In 1973 two semi acoustic models followed: The 'Les Paul Signature' guitar (**fig. 2**) and a fitting bass, now with long a neck, scale 86 cm (34 in.) They look as if an upper half of a ES335 and a lower half of a Les Paul were combined. They have two f-holes and a sustain block under the bridge but not between the pickups. Most had a gold top while some were sunburst. First they had the same oval pickups, later rectangular ones, internally side-by-side humbuck-



Fig. 2. Les Paul Signature, about 1975, semi-solid.

ers. The bass is still in production by Epiphone in the Far East branded the 'Jack Casady Signature'. Gibson used the oval low impedance pickups with their gold tops and also on the first version of the "L5S" form 1971 to 1973. The neck pickup is slanted, while the bridge pickup is straight. The low signal voltage is stepped up with a built-in transformer between the pickup selector switch and the output jack. As of 1973 the later more frequent version of this guitar had normal high impedance humbuckers.

In 1977 some details were changed on the Les Paul

Recording. The four pots moved up into a straight line (fig. 3, on the left), the PHASE slide switch and the TONE toggle switch moved downwards, and the pickup selector switch was placed opposite to the cutaway as with standard Les Paul guitars. The HI/LO switch was omitted, replaced by two output jacks. The front one is high impedance (via the transformer), the rear one is low impedance (directly). The body got a maple top like a normal Les Paul. The bevel on the back was (unfortunately!) discontinued.

Once my dream guitar

For a long time I was curious about these instruments. In a music shop I got a brochure of the Les Paul Recording with a demo foil record of Les Paul himself speaking and explaining all the functions. I was totally overwhelmed by these marvelous sounds and the great versatility. I had never heard anything like this before. I longed to own such a guitar, but as a poor student in the 70s the price was absolutely beyond my means. (*Note of the editor: you can*

hear this recordings on the Fellowship's website—see the additional resources section at the end of this article).

My dream guitar soon disappeared from the music shops and went into oblivion. According to Tom Wheeler about 5300 units were built, very few compared to the normal Les Paul guitar output. They did not become highly desired collector's items.

Many years later when I had nearly forgotten they ever existed, a Les Paul Recording came into my workshop for repair. So I had the opportunity for intense scrutiny. My first impression was that the



Fig. 3. Les Paul Recording, version of 1977.

are so many unlike any other guitar. However, in order to use them all, one must complement this guitar with the right equipment. In other words, instead of using a normal guitar amplifier, you need to use a high-quality microphone amp or PA. The main difference to normal guitars is that it can produce a very fine, glassy treble, usually only obtained from acoustic guitars with piezo pickups. In order to hear the full dynamic range a speaker and tweeter with crossover is essential.

design was in principle a noble intent, but one cannot use it exactly the same as a normal electric guitar. In order to use these instruments effectively, you need some special know-how.

First one must learn the correct handling of the controls and switches (fig. 4, below). The most important one is the OUTPUT HI / LO slide switch. In the LO position the output is low impedance as mentioned, designed for direct connection to a mixer or microphone amp. If you connect it to your usual guitar amp, the output volume will be extremely low. But if you select the HI position, the built-in transformer is activated and the output will be remarkably louder, suited for standard amps. This position, however, is unsuitable for mixer inputs. With the 1977 version one has to use the suitable output jack.

A great variety of sounds

Now a word on the sound, or more accurately, the *sounds*, because these

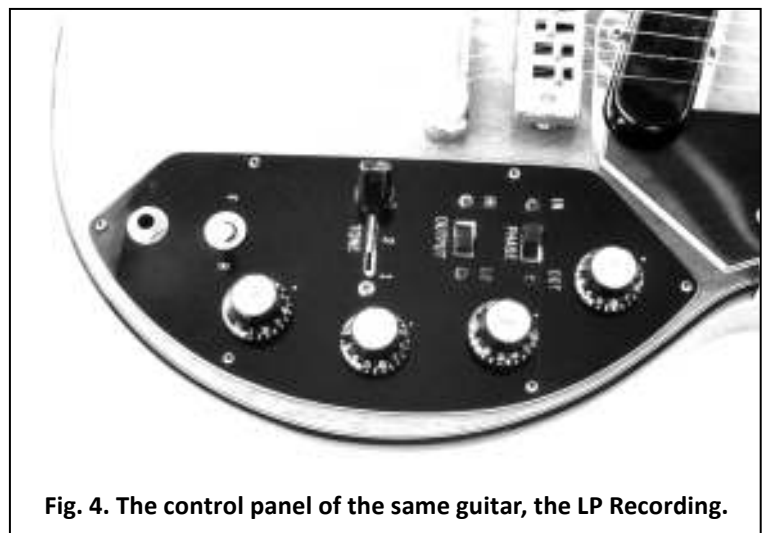


Fig. 4. The control panel of the same guitar, the LP Recording.

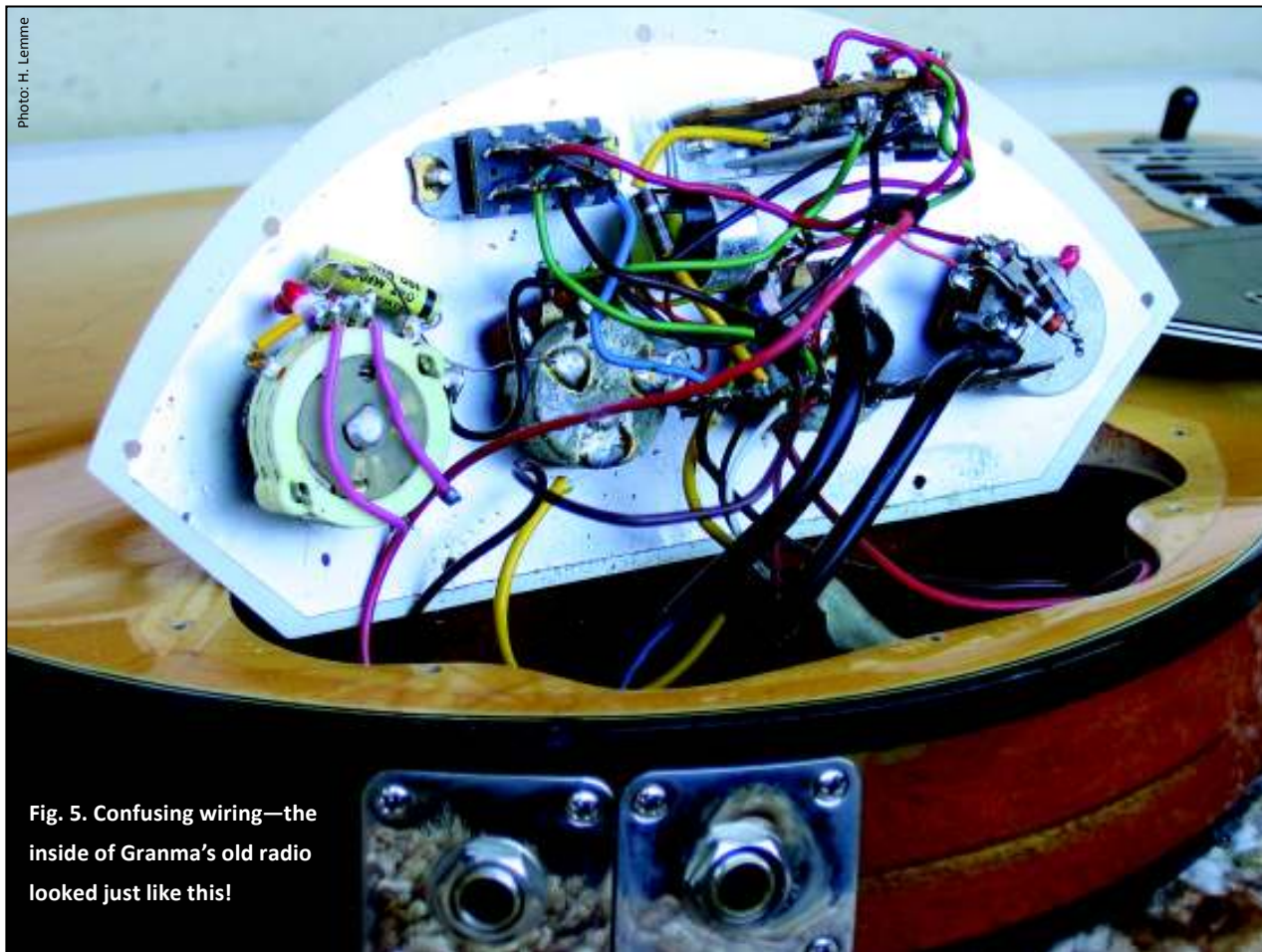


Photo: H. Lemme

Fig. 5. Confusing wiring—the inside of Granma's old radio looked just like this!

The element which is responsible for the basic character of the instrument is the 'Decade' rotary switch (the one with eleven positions). It connects different capacitors in parallel to the pickups, changing their resonant frequency. This has a crucial influence on the sound. In position '0', at the counter-clockwise end, the resonance frequency is above the audible range. The transmission characteristic is practically linear, so this is a real HiFi sound. It is also somewhat expressionless. In position '1' it becomes more characteristic, here the resonance is approximately 8000 Hz, a thin, glassy tone, as known e. g. from The Spotnicks, many years ago. In position '2' it comes down to 5600 Hz, still very piercing, very different to what one is used to from other guitars. From '3' on the tones become more familiar, twangy

like Fender. The more the Decade switch is turned to the right, the deeper the resonant frequency will become, and the warmer the tone. But the alterations of the sound from position to position get smaller and smaller. Between '6' and '10' no more large differences can be heard. The sounds remain relatively hard and have more similarity with Fender guitars than with Gibsons. The fat, warm tones known from a normal Les Paul cannot be produced in any of the many switching positions. If the treble control is turned down the tone becomes only muffled. With the bass control the deep tones can be attenuated a bit.

The pickup selection switch works as usual: upwards (F) the neck pickup, downwards (R) the bridge pickup, in the middle both. In this position

one can activate one pickup with the PHASE slide switch. In position IN it sounds normal, in position OUT there is an ‘out of phase’ sound—a very unusual, strangely hollow sound which is a matter of taste. Finally, the TONE toggle switch set in position ‘1’ connects both pickups which are always on, independent of the pickup selector switch. In the position ‘2’ the treble and bass controls work, and in ‘3’ they are deactivated. The Decade and the phase reversal switch always work.

For electronics experts: The pickups have a DC resistance of only 10.8 ohms - about a thousandth of normal high impedance pickups. The inductance—the really crucial element—is 8 mH. The frequency response without an external load is totally linear and reaches up well over 200 kHz. The pickups are embedded in epoxy resin. They are mounted with three screws and do not rattle like some others.

In the HI position of the output switch and connected to a normal guitar amplifier the tonal possibilities are far more limited. The fine glassy treble

frequencies will not appear and an additionally connected treble tweeter will not help much. The Decade switch shows only little effect. The number of remaining sounds is much less than in the LO position. As I found out, this is due to the transformer which is of inferior quality and kills the treble. So my initial enthusiasm was dampened somewhat after all.

A view under the pickguard reveals a tangle of wires like in grandmother’s radio (fig. 5, on next page). In such an expensive guitar I had expected something more professional. The schematic is shown in fig. 6. The Decade switch is connected to four capacitors, it is not a standard type but a special design which also permits a parallel connection of two or more capacitors in some positions. Some of them are *tantalum electrolyte* types, which often have wide variations. The overall capacity rises linearly from one position to the next, according to the principle “10, 20, 30, 40,...”, so the marginal effect decreases. That is the reason why between the positions of 6 and 10

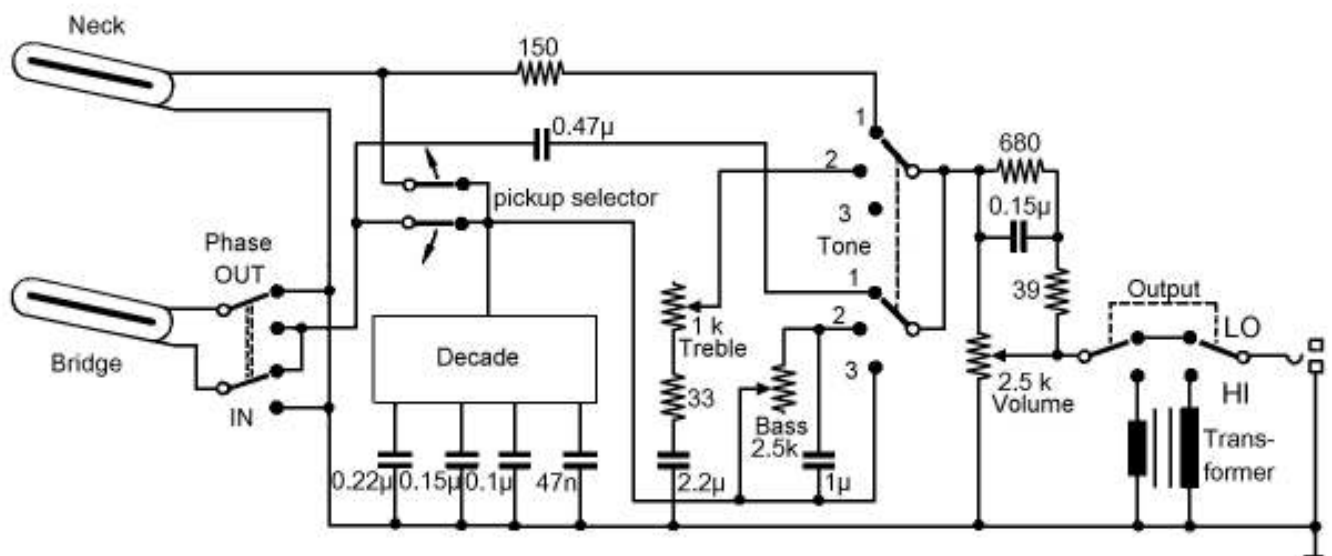


Fig. 6. The original circuit of the Les Paul Recording—susceptible of improvement.

there is so little difference in sound.

After modification: considerably better

All in all, despite of the numerous sound possibilities, I was not really content. So I decided to do some modifications. The first thing I exchanged was the Decade switch. The new one has *exponentially* graded capacitors, according to the principle “10, 15, 22, 33, 47...” (fig. 7, right). Now the relative distances of the resonant frequencies remain the same. With these the guitar can also produce some wonderful warm, soft sounds, which its inventor most probably never heard.

The next step was to replace the treble-killing transformer. Instead of a high-quality type I decided to install an active low-noise preamp which proved superior, allowing a full treble even in the HI position. It needs little current and there is enough space for it in the cavity including the 9 Volt battery (fig. 7, left). The passive treble and bass controls were replaced by active ones, which have much more effect. The TONE toggle switch I used for a passive midrange attenuator. The OUTPUT HI / LO switch works as a voltage divider at the output now, so that a connec-

tion to a low impedance input is still possible.

After all these modifications the Les Paul Recording is now really an absolute top class instrument. It is fascinating to be able to switch between so many different tones without having to change the guitar. There is only one small note of bitterness, It weighs 5 kg (11pounds). When I play it for an hour, my shoulder aches.

I had the chance to modify several guitars in this way. Their owners were all enthusiastic. Some others ordered the parts and installed them themselves. Also a “Les Paul Signature” found its way into my workshop. The controls are much simpler. The transformer is of considerably better quality here. It has three taps on the primary side to which the pickups can be connected to produce different sounds. This works much better than the original Decade switch. Here I did not modify the wiring. There was only a loose contact to be repaired. After that it was very difficult to install the wiring back into the body again. I do not understand why this guitar was not successful. It sounds fantastic.

I got an Epiphone Jack Casady Signature bass once with a defective volume control. It is a 2.5 kOhm type, placed between the pickup and the primary



Fig. 7: Taking the low impedance pickups to their highest expression: an extremely low noise preamplifier (with active treble and bass control and passive components for midrange control- left) and the improved 'Decade' switch—exponentially graded, embedded in epoxy resin, and easily exchangeable (right).



side of the transformer. The owner had replaced it with a 500 kOhm type, and that absolutely did not work. But a 2.5 kOhm pot with knurled shaft is difficult to get. So I altered the wiring. I placed the 500 kOhm pot on the secondary side of the transformer, where it works perfectly.

Ibanez tried to copy

In the 70s the Japanese started to imitate nearly all successful American guitars. The Ibanez 2372

model is a copy of the Les Paul Professional, the 2380 a copy of the Les Paul Recording (see a picture from the original Ibanez catalog on **Fig. 8, o next page**). At first sight they look nearly like the originals, but there are some small differences, for example the pickups are less slanted, and the neck is bolted on. The controls look exactly the same. The Decade switch, however, has only three positions. The treble control has nearly no effect on 98% of its angle of rotation, on the last 2% the tone becomes totally muffled.



Fig. 9. - Ibanez 2372

Photo: H. Lemme

the hum is not compensated. It was a simple job to exchange the wires of one coil, after which they were free of hum. The Ibanez 2380 type has practically the same electrical properties as the Gibson Les Paul Recording type. For better protection I embedded the pickups in epoxy resin. The other modifications were the same as with the Gibson. The transformer is of the same inferior quality. Likewise, the Ibanez 2380 became a great guitar this way: the sounds are similar, maybe not completely as brilliant as the Gibson, but fine nevertheless.

The pickups of the Ibanez 2372 (fig. 9, above) are not low impedance but normal high impedance. The problem with the coil connection is the same and can be corrected easily. Even today I keep getting many of these guitars for repair. They get a new Decade switch, active treble and bass controls and a preamp as the output voltage of the pickups is still rather low. As opposed to their original state they are now fine guitars, well suited for stage and studio use. IIII

Still more disturbing is the fact that the pickups look exactly like the originals (only without a manufacturer's logo), but they are extremely sensitive to hum interference. Only in the out-of-phase position are they quiet, but this is not to everybody's taste. Obviously they are no stacked humbuckers but single coils. However, they can be opened easily. In contrast to Gibson they are only filled with wax which can be melted and poured out. Then the secret is out. There are two coils inside, stacked on each other, but connected in a wrong way so that

Additional resources:

- Information about low-impedance pickups:
www.gitarrenelektronik.de/niederohmige-pickups
No German? No problem. Write an e-mail in English to: info@gitarrenelektronik.de Likewise, if you happen to have a guitar of this kind and are not content with it please contact the author.
- General info about pickups:
www.buildyourguitar.com/resources/lemme/index.htm
- Les Paul recordings with the low impedance guitar on the website of the Fellowship: bit.ly/T6JusN