Acoustic Guitar Repair

Acoustic Guitar Set Up's

Adjusting Action For Playability & Tone

Action is a term used to describe the way an instrument is adjusted and how well it plays. Action is most commonly thought of as how high the strings are from the frets.

A Basic Guitar Set Up Includes:

Adjusting the Truss Rod
Lowering the Saddle Height
Cutting Proper Nut Slot Depth
Checking for Loose Hardware
Cleaning The Fingerboard & Frets
Restringing & Tuning

A good set up can:

- Increase comfort by decreasing pressure on the players finger tips
- Eliminate or decrease buzzing
- Improve sustain and tone
- Improve intonation

Depending the abilities of the instrument and the needs of the player adjustments can be made to improve the instruments action and increase the comfort of playing. I like to have my customers play for me, even if they're just beginning. The opportunity to communicate and watch someone's playing style is essential to getting it right. The feel that's right for you is as unique as the instrument you play.

Setting Up An Instrument

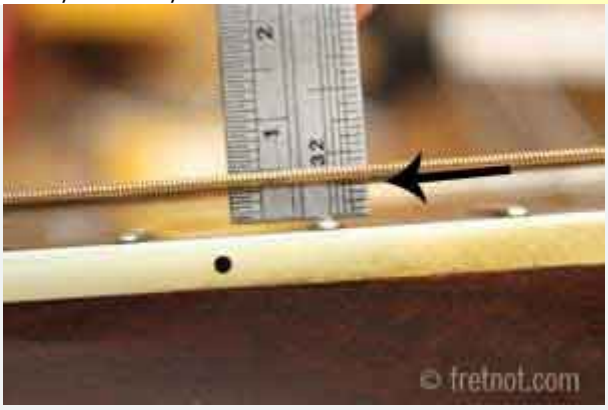
Common Measurement Conversions
3/32" = .093 = 2.3mm = .23cm
1/8" = .125 = 3.18mm = .32cm

Let's start with a few measurements...

String Height At 12th Fret

Saddle height directly affects how high the strings sit above the frets.Saddle radius/contour also affects the instruments action as the curvature of the saddle changes the strings height.
Not all instruments play the same with the identical set-up and a player's pick attack and style will certainly contribute to how an instrument is set up. I mention this because it can be the difference between a professional set up, and one "done by the numbers".

What is the most common string height?Most factories set action at 3/32" to 7/64" on the bass E string at the 12th fret and 2/32" to 5/64" on the treble E.



Measure Distance Between
Top of 12th Fret and Bottom of String

Place a ruler on top of the 12th fret and measure the distance between the top of the fret and the bottom of the outer E strings.
High action on an acoustic guitar not only affects the intonation, it can make the instrument difficult, if not painful, to play.

String Height At The Nut

String height at the nut should be as low as possible without causing open string buzz. The distance between the string and the 1st fret would nearly always be below 

.020 (.5 mm). When I am certain of the condition of the frets I set action at the nut as low as possible. String height at the nut can also be affected by the condition of the frets, string gauge and pick attack.
To check string height at the nut, fret each string on the 3rd fret and check the gap between the string and the 1st fret. While some instruments may still play clean if the string is touching the first fret, most will require a gap of a few thousands to avoid buzzing.

Proper Nut Specs

- Outer string positioning to prevent fret edge roll off
- Equal string to string spacing
- Bottom slot angle provides sustain and clarity
- Slots width keeps strings from binding
- Depth to provide lowest action and best intonation.

Correct Neck Relief

Appropriate relief (bow) in the neck gives the strings amble room to vibrate without hitting the frets. Too much relief and a neck feels "mushy" towards the center. Read more about this adjustment on thetruss rod page.

Intonation

An instrument that is not intonated properly will not play in tune when moving up and down the fingerboard. Even after tuning the guitar, players will notice certain notes are sharp or flat. Correcting intonationissues obviously makes a big difference in the way an instrument sounds.

Level and Well Crowned Frets

Frets need to be perfectly level and have a nicely formed crown. Frets of inconsistent height can cause buzzing, also know as fretting out.

Things That Can Raise or Lower String Height

Humidity / Dryness

Moisture causes the woods of an instrument to swell, loss of moisture will cause them to shrink. Most will find that during the summer or times of high humidity the top may swell and lift the strings higher off of the fingerboard making it more difficult to play. On the other hand, instruments that have been left without proper humidity will often become dry, which can cause the top to drop and create buzzing problems. You may also encounter sharp fret ends that are now exposed due to the shrinking of the fingerboard. During times of low humidity it is essential that you keep your instrument properly humidified. Read more about humidity.

Wear and Grooves

The grooves of the nut and/or bridge saddle will wear as the strings pass over them. As the strings pull to and fro across the nut andsaddle they are slowly but surely deepening the groove. Excessive

wear in the nut slots may cause the strings to buzz when played open since they are now too close to the frets. Grooves in the saddle can affect intonation and cause strings to break

Tension and Top Bellying

It is particularly common for the action on flat top instruments to raise over time due to the tension placed on the top. The strings continual pull on the bridge and top can create a slight arching which raises the action over time. While a slight arch is quite normal, greater changes in the tops shape may be and indication of structural problems such asloose braces or a warped or cracked bridge plate.

Changing String Gauge

If you change the gauge of strings you are using, be it heavier or lighter, there will be a change in tension on the top and neck of the instrument. When setting up an instrument you must choose what gauge of string you will be using so that the action can be adjusted accordingly. Changing the string gauge will effect your set up.

Structural Problems

Loose braces, loose bridges, loose necks, cracks and other structural problems may first become apparent when a player notices a significant change in an instruments action.

Guitar Binding Repair

Binding is found on many instruments and can be used along the outline of the top, back, peghead and fingerboard. Not only is binding decorative but it also serves to protect and seal the end grain of the wood.

Binding Problems

Shrinkage

Shrinking binding can often be reglued if its condition is still solid.
Extreme or fluctuating temperature and humidity levels can cause binding to loosen. Wood will expand and contract as the humidity changes, the more drastic the changes, the more stress to the glue joints. To prevent stressing the glue joints an instrument should be kept properly humidified.

Celluloid Binding Decay

Decay

Celluloid's deterioration can be so severe that replacement is the only option. Severe deterioration of the bindings and celluloid pickguard on certain vintage instruments can also effect the surrounding area by causing corrosion of nickel and other discoloration, particularly when the instrument has been stored in a closed case for decades.

Cracking

A common area to see binding cracks is at the end of the frets. When fingerboards shrink due to dryness the frets may extend past the edge of the shrunken fingerboard placing pressure on the binding. This results in fine line cracks at the ends of the frets.

Repairing Loose Binding

If binding has seen considerable shrinkage or been subjected to humidity and temperature changes, the binding may come loose from the body or neck.
The tight area of the waist is a very common spot for binding to loosen. If the shrinkage is minor the binding can sometimes be gently pushed back into place and reglued. Considerable shrinkage leaves the binding too short to simply force back into place as the tension would surely cause it to pop loose again or not seat properly.

Regluing

In instances where the binding has not cracked but has simply come unglued I frequently choose to loosen the binding to the point of the manufacturer's original seam to remove the tension created by shrinkage.
To avoid damaging the finish, Titebond is often used to repair small areas of loose binding after the channel and binding has been scraped.

Binding loosened to factory seam at heel.
Masking protects instrument from strong adhesives that damage finish.

Repairing Cracked Binding

Binding on the fingerboard and body can develop cracks, especially if the instrument has been thru extreme temperature or humidity changes.
Loose binding is easy to snag and break.
A fingerboard can shrink if humidity levels drop too low. As a result the frets are then wider than the board, placing pressure on the binding which can cause cracks near each fret.. Be sure to address humidity concerns to avoid more damage.

Finish Considerations

Because binding is under the finish, removing it will cause chipping of the finish along its edges. This is a consideration when choosing the proper method of repair. Instruments with thinner finishes may show far less evidence of a binding removal and repair than one with a very thick finish. Generally speaking refinishing is avoided when regluing loose bindings and repairs are noticeable but not terribly unattractive.
Replacement of binding often requires finish work.
While the type of adhesive used for binding repair will vary according to the type of binding and the situation, many of these adhesives are harmful to the finish itself. Extra care must be taken to thoroughly protect the finish when performing binding repairs.

See also: Binding Replacement

Loose Guitar Braces

Loose Back Brace

Braces reinforce and strengthen the top and back of most acoustic instruments. The braces on an acoustic instrument bare the brunt of string tension placed on the instrument and it is essential that they be securely glued in place. Because most acoustic flat tops are no more than say .100+/- of an inch, braces play a huge role in keeping everything together.

Signs of Loose Bracing:

- Bulging
- Top rotation (dip in front of bridge, hump behind)
- Ripples / Waviness on flat panels
- Cracks
- Rattling/vibration/changes in tone
- Stress to glue seams

Checking Braces

Some times we aren't aware of loose braces. They are usually discovered by inspection after a bulge is noticed, a rattle is heard or perhaps a bridge repeatedly comes loose.

A thin feeler gauge will slide under a loose brace.

I start by inspecting the interior of the guitar with a light and mirror, but sometimes that isn't enough. Loose and split braces that have no visible gap can be difficult to spot.
After eyeballing it I turn to my favourite brace checker, a simple feeler gauge. A thin feeler gauge will easily slip between a loose brace and the top or back.

Cracked / Split Braces

A cracked/split brace can elude even the best eagle eyes. While inspecting the braces with an interior light and mirror a split brace may give no cosmetic clue as to it's whereabouts. Handling each brace is sometimes necessary to locate the mystery brace as the crack can be very fine with no gap or separation.

Paper strip shows location of a hidden crack

Even though these braces are radiused (shaped to render the top/back slightly arched) this one has begun to curl up excessively. Warping can occur when a brace is left loose for a long period of time or the instrument is subjected to a dry environment.

Gluing Loose Braces

Before gluing the brace, old glue must first be removed to insure good adhesion. I go to great lengths to avoid leaving glue behind which would make these kinds of repairs most obvious.

Loose top braces are often glued using deep c-shaped clamps available thru luthier supply companies.

Back braces are often glued with the use of interior "jacks". On occasion I may use an interior jack in combination with an exterior clamp. This allows me to place greater pressure on a back brace without the risk of damaging the instrument.

I use a small nylon wedge to lift the brace away from the panel and permit glue application.

What glue is used to repair loose braces?In most cases an aliphatic resin glue such as Titebond regular water soluble glue is used. Some vintage instruments may warrant using hide glue.

"Jacks" are often used to glue loose back braces

Replacing Braces

When left un repaired a loose brace can actually come completely free from the top or back. On many occasions I have inspected a guitar only to find a missing brace, one can only wonder where it got off to.

When dealing with flat top acoustic guitars with typical, round soundholes, most braces can be repaired without removing the back.

As seen in a previous photo, a loose brace can warp over time. Excessive warping can make the brace far to stiff to be clamped back into position. In such cases removal and/or replacement is often necessary.
I have successfully made an installed many top and back braces without removing the back. This excludes the X brace, it is two braces where one lies over another. This is tedious work as the radius must be copied and the brace positioned while placing ones hand, clamps, mirror and light inside the sound hole all at once. Difficult access does require the back to be removed for some repairs.

Acoustic Guitar Bridges

Gluing A Loose Guitar Bridge

It is important to check the glue joint between the bridge and top to ensure there are no gaps.

Thin paper slid beneath loose bridge.

A thin piece of paper can be used to determine the extent to which the bridge is loose. If there is evidence that the bridge is loose it should be inspected and repaired if necessary.
Neglecting a loose bridge can create more damage if it breaks free and tears fibers from the top. A loose bridge can also shift forward and damage the finish.

Possible Causes:

- Heat / Dryness
- A loose X-brace
- Glued to painted surface
- Damaged bridge plate
- Insufficient glue

Before a loose bridge is reglued it is removed from the top. I use specially designed heating blankets which direct the heat to the bridge and avoid overheating the top or finish. A flexible, smooth spatula serves to separate the bridge from the top once the adhesive is softened.

Regluing loose bridge

All old glue is removed from the top and bridge to provide a clean surface for re-gluing.
A bridge caul is used to evenly distribute the pressure and a clamp is used with exterior and interior cauls.

Heat / Dryness Can Soften Glue

Leaving an instrument in a hot car, attic or other hot environment may cause the glue to soften which can allow the bridge to shift or creep forward. Unfortunately this usually does some damage to the finish as well.

Loose X-Brace / Top Deformity

The X-brace helps to stiffen and strengthen the top of the guitar. It runs beneath the ends of the bridge and helps prevent a certain amount of top "rotation" and arching. When braces come loose string tension can change the shape of the top, causing excessive bellying behind the bridge, unsymmetrical bumps in the top and even a concave dip in front of the bridge.
If the top's shape changes radically it can place incredible pressure on the glue joint between the top and bridge. Structural repairs are made prior to regluing the loose bridge and sanding of the bridge's base can improve the fit.

Bridge Glued To A Painted Surface

I don't believe I have ever seen this on an expensive instrument. Obviously this undesirable technique is chosen because it saves the factory time, however, it usually has poor results and almost always means the bridge will come loose ...eventually.

Finish was not removed prior to bridge gluing.

The finish must be removed so the bridge can be glued to the bare wood of the top.
If the finish is very thick this can create a cosmetic problem. See Special Considerations below.

Bridge Plate

A cracked or warped bridge plate can also allow the top to deform, placing incredible tension on the top to bridge glue joint.

Insufficient Glue

Excessive clamping pressure may force too much glue out of the glue joint, though this is rare. Usually I see this on instruments where the bridge was not glued with traditional wood glue.

Other Common Bridge Problems

Cracks

Cracks normally develop in two places on acoustic guitar bridges; thru the bridge pin holes and at the edges of the saddle slot. Minor cracking thru the bridge pin holes can sometimes be repaired when there are no other issues with the bridge. It is usually inadvisable to repair cracks at the edges of the saddle due to the constant tension.

Warping

Bridges that have been loose for a length of time can distort in shape. If enough twisting occurs replacement is necessary.
A small amount of warp may be repairable by heating and clamping the bridge or planeing of the bottom when the bridge is thick enough.

Thinned / Modified

A neck reset is a costly repair to consider on inexpensive instruments. In an attempt to lower action on an instrument that needs a neck reset the bridge is sometimes thinned or modified. This is done because the saddle is already as low as possible.
When resetting the neck on an acoustic guitar who's bridge has been previously thinned it is advisable to replace the bridge to return it to the correct height.

Incorrect Saddle Placement

Intonation problems caused by an inaccurate placement of the bridge and/or it's saddle may also require bridge replacement. My article on intonation will shed more light on this subject.

Does the bridge effect tone? The bridge is a top brace, albeit an exterior one. A loose bridge weakens the structural integrity of the top and can affect the tone as a result of the poor coupling.
An overly thin bridge also changes the dynamics of tension/torque placed on the top and the distance of the strings from the soundboard.

Special Considerations

Painted Guitar Bridges

Removing certain painted guitar bridges poses another problem. Most manufactured classical guitar bridges are glued to the top before finish is applied. When these must be heated for removal the finish would need to be stripped to avoid a mess. Any plastic inlays on the tie block would also suffer damage. This requires stripping and refinishing of the bridge. For this reason it is often easier and cheaper to replace these when necessary and available.

Plastic Inlays

Some acoustic guitar bridges have been inlayed with plastic (celluloid) inlays. The heat necessary to soften the glue and remove the bridge will normally destroy celluloid, it must be removed or replaced. Heat does not harm actual pearl inlay, it simply melts the glue.

Thick Top Finishes / Poor Surface Preparation

In order to reduce prep time some factories may forego removing the finish beneath the bridge. Bridges glued to finish often pop loose, sometimes leaving pieces of the finish still glued to the bridge.
Other manufacturers leave a small outline of finish around the bridge to ensure no bare wood is exposed around the edge of the bridge. It's important to realize that not all gaps around the edge indicate a loose bridge, as mentioned before, using a thin piece of paper around the edge can help determine how loose the bridge is.

The Exception

The only time that I would avoid removing the finish and instead, glue a bridge back down to it is when the finish is terribly thick. Think import guitar with polyester finish!
A very thick finish is not only difficult to remove, it leaves a ledge of considerable thickness which would be hard to disguise. While this means the bridge may very well come loose in the future, the alternative is unsightly. One would need to scribe around the bridge, clear the finish and "inlay" the bridge into the clearing.

Bridge Plate Repair

Bridge plates are most commonly made from **maple or rosewood** and less frequently, spruce.

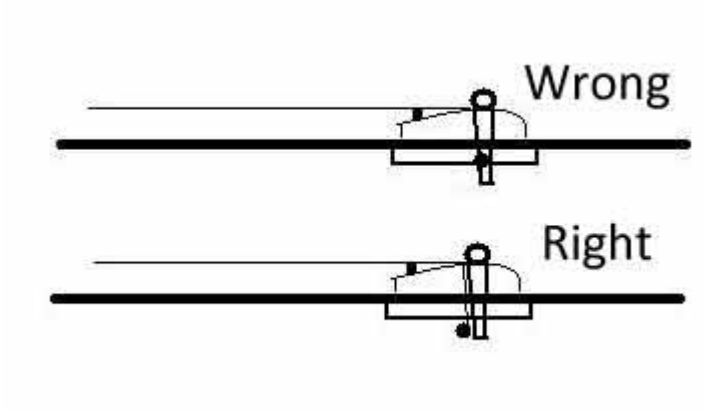
String ends seated firmly against maple bridge plate.

While the size and thickness of bridge plates differ, it's purpose is to reinforce the top and keep it from bellying (arching) excessively at the bridge where the strings place incredible tension on the top.

Common Bridge Plate Problems

Wear and Tear Around Bridge Pin Holes

The ball end of the strings should hook around the edge of the bridge plate and be held there by the bridge pin. When the hole is enlarged by wear, the ball end of the string often pulls itself up into the hole instead of against the plate.



Why do my bridge pins want to pop out when installing new strings? The ball end of the string wears away at the bridge plate, causing a once round hole to take on a keyhole shape. This wear permits the ball end to pull "up" into the plate and does not allow them to lock against the plate.

When the ball end of the string no longer catches against the plate it often results in **flying bridge pins**.

Another commonly seen symptom ...the thicker string winding which wraps around the ball end can now come close too or even touch the saddle. When this occurs the saddle may incur damage and intonationmay be affected.

The string's end winding is contacting the saddle.
This can cause excess wear on the saddle and problems with intonation.

Warped Bridge Plate

Many believe that smaller, thinner bridge plates attribute to good tone. They may also suffer from warping and cupping after years of string tension.

> Several manufacturers have flip flopped when choosing bridge plate size and thickness. The catch 22 here is that smaller, thinner bridge plates sound good but often lead to more costly repairs due to top bellying. As a result , certain manufacturers have gone from too small, to too large to just about right thru the years.

A badly warped bridge plate may cause the top to belly excessively or distort in such a way that the bridge can not longer stay glued to the top due to the change.

Cracked Bridge Plate

Though not particularly common, bridge plates can crack. When this happens it often occurs thru the bridge pin holes.

Loose Bridge Plates

When checking for a loose bridge plate I will start by inspecting them with a light and mirror, if any doubt remains I will use a thin feeler gauge to insure there are no gaps present.

Removing Bridge Plates

As many of you have guessed, removing the bridge plate is not without risk. Heat and/or moisture is often used to soften the glue between the bridge plate and top. Because the top is relatively thin one must avoid overheating the area which can damage more vulnerable finish such as lacquer. Unfortunately accessing the plate thru the soundhole leaves room for little else ...like mirrors. This is one task that is, for the most part, done by feel.
I use a number of hand made tools which allow me to work my way under the bridge plate and separate it from the top.
Once removed, a new bridge plate is made from scratch and glued in place. To avoid splintering the bridge pin holes (which is commonly seen on inexpensive instruments) the new holes are drilled undersized and reamed to the correct dimensions. Tear out, which is often seen when the holes are drilled improperly can promote premature bridge pin hole wear if chips and tear out occurs around the hole.

Repairing Worn Bridge Plates

While warped, cracked and loose bridge plates should be replaced, worn bridge pin holes can be repaired without replacing the plate in some cases.

Gibson guitar bridge plate showing signs of wear.
Note the screws which go thru the bridge and are hidden beneath inlay.

I have used a couple of different methods to repair worn bridge pin holes including plugging and re-drilling them. For simple wear and tear however an easier method is to install a PlateMate© which will completely cover the worn holes.

Rosewood bridge plate with PlateMate© installed
allowing the strings ball end to catch securely on the edge of bridge plate.

It can be very aggravating trying to string a guitar who's bridge pins continually pop out when string tension is applied. To lessen the effect I recommend you put a **gentle** bend in the end of the string at the ball end which will encourage it to hook and lock onto the edge of the worn hole. You can also turn a fluted bridge pin around, placing the groove away from the string to further close the gap as well.

Guitar Bridge Pins

The ball end of the string locks against the bridge plate and prevents the strings from flying out, but once the round hole becomes elongated it can permit the string's ball end to pull up into the bridge plate. As the ball end pulls into the hole it forces the bridge pin out, usually with gusto!
As a means to lesson the effect you can put a gentle bend in the end of the string (at the ball end) which will encourage it to lock onto the edge of the hole. You can also turn a fluted bridge pin around, placing the groove away from the string to further close the gap as well. Severe wear will require bridge plate repair.

Why do my bridge pins want to pop out when installing new strings? The ball end of the string wears away at the bridge plate, causing a once round hole to take on a keyhole shape. This wear permits the ball end to pull "up" into the plate instead of locking against it. Read more about bridge plates.

Types of Bridge Pins

Fluted (grooved) and Solid bridge pin

Fluted bridge pins have a groove cut in them which provides room for the string to pass between the pin and bridge.

Solid bridge pins require notches in the bridge to accommodate for the strings diameter.

Because the bridge pin material can effect the tone and sustain on an instrument, some may desire to experiment with different bridge pin materials.

Common Bridge Pin Material

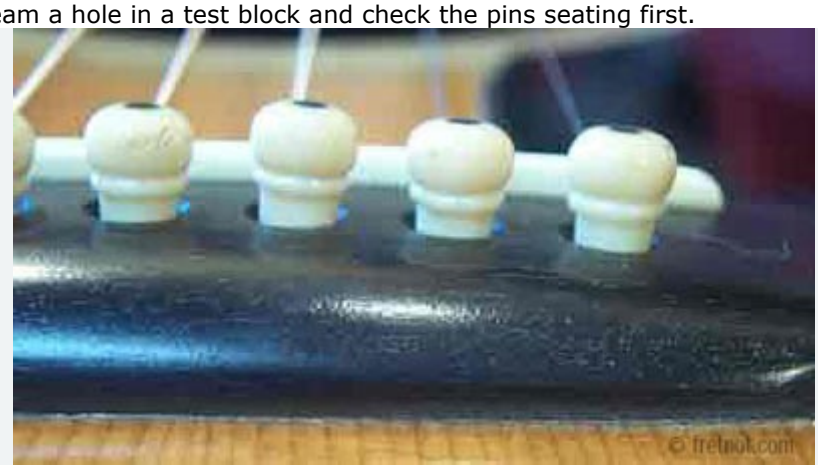
- Wood- Ebony, Boxwood, Rosewood etc.
- Bone - FWI, Mammoth Ivory, Bone
- Plastic - Tusq®, ABS etc.
- Metal - Alloy, Brass

Fitting

Though bridge pins come in different sizes/tapers the most common is 3° and 5°. On occasion it is necessary to fit bridge pins so they will seat correctly, this is done with **bridge pin reamers**. A bridge pin reamer normally has only one cutting edge/blade to produce a nicely rounded bridge pin hole free from chatter.

I have seen some factories drill the hole thru the bridge and bridge plate without reaming it for proper bridge pin fitting. These pins often sit very high on the bridge.

When purchasing custom bone or ivory bridge pins, make sure to inquire about the different bridge pin sizes available. This will allow you to choose the correct bridge pin reamer to create a proper fit. If unsure, ream a hole in a test block and check the pins seating first.



Guitar Buzzing ? Fix Fret & String Buzz

Types of Guitar Buzzing Problems

Fret Out or String Buzz - This happens when a string comes in contact with a fret and a buzzing sound occurs. This is the most frequent cause of annoying buzzes. See chart for diagnostics.
Hardware Buzz - Parts can also cause buzzing. Probably the most common items which buzz on acoustic guitars are loose input jacks and loose tuning machine bushings. Pre-amps and pickup components that are not seated well can also rattle.
Sympathetic Buzz - Thankfully this is not too common. Certain frequencies can set off strange rattling and vibrations. These types of buzzes differ in that they occur only when certain frequencies are played.
Loose Brace Rattle- Braces that split or come loose in an acoustic guitar can sometimes be heard rattling against the top or back when playing or tapping.

Causes of Fret Buzz

Symptom	Possible Cause	Remedy
Open String Buzz Buzzes when played open, stops when string is fretted.	**Nut** Worn or poorly cut nut slot is placing the strings too close to the frets near the nut.	Replace nut or shim to add height. Set up instrument properly.
One Spot Buzz Buzzes on one note, or one area but stops when moving away from that spot.	**Frets** Frets are not level, one or more is too high/low. Loose or sprung fret is rising out of the fingerboard. Hump in fingerboard. Wear or deep grooves in frets.	Secure all loose frets, level and dress. Fret leveling and/or replacement of worn frets.
Upper Fret Buzz Buzzes where the neck attaches to the body. Notes seem to fret out when playing near the body.	**Fingerboard** On acoustics, section of fingerboard that is glued to the top may rise/fall with temperature/moisture extremes due to changes in the top. Fingerboard is warped in a way to render the end too high (most common on archtop's).	Evaluate for dryness, humidify if necessary. Frets near f/b extension may need leveling. In rare cases the board must be planed to remove hump.
Buzzes When I Strum Hard Buzzing occurs when strumming or picking aggressively but can be silenced when playing lightly.	**Set Up** Insufficient relief in the neck. Poor set up. String gauge too light.	Adjust truss rod. Set up instrument properly. Use heavier strings.
Buzzes Everywhere Buzzes nearly	**Frets** Frets may be worn out or too low.	Replace frets.

everywhere even though it is set up properly, will often disappear if string is fretted hard or closer to the fret and plucked softly.	Very small fret wire used.	
Frets Out Buzzes nearly everywhere all the time, strings are literally touching the frets in the center or other area of the fingerboard.	**Neck** Truss rod may be way too tight back bowing the neck. Neck could be a warped, or have excess back bow even after truss rod is loosened.	Set up instrument properly. Adjust truss rod for more relief. Use heavier strings if relief can not be created thru truss rod adjustm

Is Your Guitar Too Dry?

Learn to properly humidify your guitar, spot signs of dryness and avoid damage.

Damage Caused By Dryness

Guitar with concave top.

Shortly after heat systems are turned on I am frequently flooded with crack repair inquiries.

Open Center Seam

Open Center Seams

Nearly all flat top acoustic guitars have tops that are made from 2 pieces of wood. You will often hear the term "bookmatched top" as this describes the process of taking two pieces of wood cut from the same log, like pages of a book. These two pieces are layed open and glued down the center.

When dryness begins to flatten the top this seam is commonly the first to give way under the stress.

Are cracks covered by warranty? Cracks resulting from a lack of humidity or extreme heat are not the result of a manufacturing defect and therefore manufacturers do not cover this repair under warranty. Also be aware that some manufacturers will void the warranty of a very dry instrument.

Temperature Extremes

Dangerous environments include:

- A hot car
- Direct sunlight
- Near a wood stove, fireplace or heater
- The attic

Heat is used to loosen glue joints on guitars for repair. Excessive heat can soften glue joints and allow them to loosen or slip. One of the most common predicaments I see on flattop guitars as a result of excessive heat is a sliding bridge. Once heated, the bridge can lift or actually begin to slide towards the sound hole. While this is easily spotted there are other areas of the instrument that can be adversely affected that are not as easy to spot. Frets, neck joints, braces and literally anywhere glue is used can be affected by heat.

Finish checking and crazing are often the result of temperature shock caused by taking a very cold instrument into a very warm environment suddenly.

When instruments are shipped or transported during the winter it is highly advisable to let the instrument slowly warm up to room temperature before removing it from the shipping carton or case.

Severe Finish Checking on Mahogany Topped Gibson

Signs Of A Dry Guitar

Washboarding / Top Grain Prominent

This resembles a washboard in my mind. I personally use the term**corduroy**. These are raised lines in the top which are noticeable to the touch. The soft wood between the darker grain lines has lost its moisture and the grain now stands prominent. Warning: once this becomes severe cracks are usually imminent. Take heed, this may be your last chance to avoid cracks.

Dried Spruce Guitar Top
Lines, which resemble corduroy are a common sign of dryness.

Sharp Fret Ends

The fingerboard has shrunk due to the loss of moisture but obviously the metal fret wire does not. The frets are now wider than the fingerboard and the sharp ends can become apparent. yow! This is particularly noticeable on unbound fingerboards.

Action (String Height) Lower

The top has begun to flatten out as it looses moisture and the action is lowered as a result. The fingerboard extension (portion of the fingerboard which is glued directly to the top) may also sink a bit causing a bend in the area where the neck and body join.

Concave Top

After dead flat comes concave. If you've gotten to this point without a crack you are very lucky.

Cracks / Opening Seams

After a fair amount of moisture loss an instruments wood panels begin to shrink. Eventually this change can prove too stressful for the wood and it cracks.
If left unattended these cracks can spread open and create even more costly and highly visible repairs.
Ideally, humidity should be kept around 45%.

How do I humidify my guitar?

When the humidity in your home is very low (say 20-35%) it is best to use a room humidifier in conjunction with an instrument humidifier. If the air is very dry, a small sponge is likely to be insufficient. And for those with a collection of instruments, refilling instrument humidifiers could be quite a chore, easier instead is to control the rooms humidity with a room humidifier.

Where To Start

- Install a hygrometer to read humidity in your home
- Install a soundhole humidifier and/or a
- Use a room humidifier
- Keep humidifiers filled
- Store the instrument in its case

Too Much Humidity?

The reason it's important to use a hygrometer is to determine the humidity levels in your home. While low humidity is very common in the winter here in Virginia, not all areas share our troubles. In the summer humidity levels generally stay around 50% and above, eliminating the need for humidifiers during those times.
Instruments that find their home on islands and states where humidity is very high can also be affected by the high humidity and rather than needing additional moisture, they need less.

Precautions

Drips

Anytime a humidifier is used with an instrument it is essential that water is not allowed to drip into the instrument. If enough water is spilled inside of an instrument the wood can swell and create finish damage or haze.
Also keep in mind that, depending on your location, humidity levels may increase during the summer and eliminate the need for a humidifier.

Silica Gel Packets

 The purpose of the silica gel pack is to absorb moisture and keep everything dry. Unless you are living in a humid area these are not necessary and can do harm. Apparently it is the case manufacturers who place them in the case.

Storage

It is usually best to store the instrument in the case. Not only does it protect it from damage, the case can offer more protection from severe and sudden environmental changes.

Cleaning Guitar Finishes, Fretboards & Frets

Cleaning The Finish

The type of finish (gloss, satin, lacquer, poly...) and physical condition of a finish can help determine the best method of cleaning.
If we were to compare cleaners to sandpaper, **we are choosing the least abrasive cleaner that will do the job**.

Polishing Cloths

PROS Easy, fast clean up, no residue to accumulate in cracks
CONS Won't remove heavy dirt and grime

While a nice flannel cloth is adequate for many players, those trying to polish dark finishes will find that a high quality Microfiber Cleaning Cloth is a better choice. Microfiber is very soft and adds less swirl marks than more abrasive materials. It is hard to avoid tiny swirl marks in any finish so you want to use the softest material possible on dark finishes to keep them to a minimum. Excessive cleaning and rubbing on dark finishes and gold plated hardware should be avoided to lessen the effects.
While cloths alone don't remove heavy dirt and grime they are excellent choices for players who like to wipe their instrument off after playing.

Spray Cleaners

PROS Non-abrasive, safe for satin finish
CONS Can make a mess of heavily soiled finishes

Spray cleaners are liquid cleaners that contain a fair amount of water. They are good for a quick cleaning where removal of smudges and fingerprints is the basic requirement.

A Word About Satin & Flat Finishes

Spray cleaners are also preferred over paste cleaners for non-glossy finishes. Satin finishes take on a somewhat shiny appearance particularly in areas under constant friction like the back of the neck

or where your arm rest on the top with time. In order to slow the process, overzealous polishing should be avoided as friction creates shine.

Spray Cleaner used on very dirty finish

Avoid Spray Cleaners On Very Dirty Finishes

Using liquid spray cleaners on heavily soiled instruments can create a bit of a mess.

I see this most often on instruments that are heavily soiled, think "dirt so thick you could scrape it with a fingernail".

Dirt will absorb the water in the spray and turn white or yellowish. While the sight gives pause it is a sure sign you are not going to get very far cleaning with spray.

At this stage I resort to using paste polishes or compounds for removal of dirt, usually with allot of elbow grease.

Paste Polishes

PROS Shines lightly dulled finishes, removes fine scratches and dirt
CONS **Not recommended** for **satin finishes**, can build up in cracks

Paste polish can accumulate in chips in the finish

When cleaning more heavily soiled finishes or trying to restore the natural gloss that has dulled, a non-abrasive paste polish is a good start. These cream polishes will usually remove dirt and very fine scratches.

When cleaning delicate finishes or one's with chips and scratches I recommend applying the polish directly to the cloth. Working the polish into the cloth helps reduce the amount of build up that can form if one gets polish on bare wood or in cracks and finish chips.

Dried polish turns white when dry. Avoid using paste polishes on raw wood (fingerboards and bridges) and use caution when polishing near cracks or finish chips to avoid impacting them.

Buffing Compounds

PROS Works on deeper scratches
CONS Requires some expertise to avoid trouble

Obviously not all scratches can be removed with non-abrasive paste cleaners ...and that's a good thing because we don't want to accidentally be buffing thru our guitar's finish.

Polishing compounds are similar to sandpaper in that they come in many different grades and abrasions. Most of us use them in conjunction with a machine buffer due to the time and strength required to do it by hand.
I have restored and improved many finishes by light wet sanding and buffing, however, this is something best left to someone who has the experience required to avoid a catastrophe.
Machine buffing and coarse compounds are literally removing the top layer of finish. If too much is removed you can burn thru the finish completely leaving raw wood exposed.

Vintage Guitar Finishes

On older instruments with thin or damaged finish it is best to get some advice on cleaning it.
De-laminating finish, heavily chipped or thin finishes can pose problems when cleaning.

Cleaning Fingerboards

Painted Fingerboards

Some fingerboards have been clear coated, **maple boards** and**Rickenbacker** come to mind. On painted fingerboards I use paste polish, not steel wool, to clean the board and frets.
Polishing frets with paste polish will turn your cleaning cloth black. If cleaning a maple fingerboard with worn, exposed wood, avoid contaminating those areas with the blackened cloth.
Fingerboards sprayed with a flat or satin finish can become glossy with repeated polishing and friction.

Unfinished Fingerboards

While 0000 steel wool is still a staple around my shop for light cleaning, I hate the mess it makes. I frequently use Dunlop's Fingerboard Cleaner in my shop and really like it. It does a good job of cleaning heavy dirt without having steel wool hair everywhere. Make sure to use a rag you intend on tossing afterwards as a filthy board will make a mess of your nicer Micro fiber polishing cloths.

Oiling The Fingerboard

Oiling an unpainted fingerboard makes the board look good and may help to prevent dryness which can lead to cracks. While there are many oils safe for fingerboards, some may leave a sticky residue which attracts dirt. Mineral oil, Danish oil and lemon oil are all popular choices. Weekly oiling is not necessary or
recommended.
In general, oiling the fingerboard a few times a year should be sufficient for average playing use. Severe cracking of the fingerboard can be a sign of dryness and the instrument should be properly humidified to avoid more damage.

Cleaning Frets

Clean and polished frets are not just pretty, a highly polished fret crown makes for some slick string bending. While steel wool certainly cleans fingerboards and brightens up dull nickel it does little to create the super fine polishing that's associated with a first class fret polish.
Micro-Mesh polishing cloth is one of my favorite products for polishing frets. Micro-mesh is available in several grits, just like sandpaper, but is fine enough to use without fear of changing the fret's height.
For the do-it-yourselfer who is frequently cleaning their frets and is not looking to mask the entire board and spend a good deal of time polishing the frets, a product such as Planet Waves Fret Polishing Kit (pictured) or the popular **Gorgomyte Fret Cleaning Cloth** will do the trick.

How To Turn A Lefty Into A Righty (and vice versa)

Requirements

Nut Replacement

In order to "convert" an acoustic guitar a couple of things must be changed. First, the nut must be replaced as the string slots will be too small to accommodate the bass strings and too large for the treble strings. Simply cutting the small slots wider for the bass strings will still leave the treble strings to vibrate freely in the large slots which no only looks bad, it usually results in buzzing. Because of the shape of most nuts, it is not possible to simply flip them around.

Saddle Slot Angle

The angle of the saddle slot on an acoustic guitar/bass determines string length and has a direct and profound effect on the instrument's intonation (it's ability to play in tune in all areas of the neck).
In order to correct the intonation and reverse the angle of the saddle the slot must be filled and pre-cut, or the bridge completely replaced.

Pickguards and Trim

Pickguards, while they can be removed, often leave a very noticeable 'tan line', so many players opt to leave them and simply add another or go without.

Saddle slot is filled prior to re-routing the correct position.

Make a 12 String into A 6 String

Some will read that heading and think..."duh, like leave 6 strings off genius" and while you'd be correct there are other issues to consider.

Considerations

Neck Width

The first issue that dissuades most would be the width of a 12 string neck. If you like neck width akin to a classical guitar then I suppose that may not be a big deal.

Bracing

Another thing to remember is that a 12 string guitar is braced for 12 strings. Most of the time the reduction in tension due to the missing strings simply does not excite the top in a way to produce a good tone, albeit there is likely to be exceptions.

Neck Stiffness

A few 12 string guitar may have such stiff necks that they do not bow or relieve properly without the tension from all 12 strings. In those cases, after releasing all tension on the truss rod the neck still fails to pull itself straight or provide a suitable amount of relief.

Cost

Professional conversions would require the top and the neck to be replaced, which will exceed the cost of many moderately priced guitars as this is being done by a luthier, not in a factory where equipment does 90% of the work.

Keep in mind that the original top is braced heavier, has a much larger bridge, has a bridge plate with 12 holes in it. A neck built for a 6 string guitar will have a fingerboard that is not as wide as the original, which would leave obvious tell tale signs where the original glued to the top and where the heel meets the body.

So, now one can understand why my reply is normally...go shopping for a 6 string guitar or ...leave 6 strings off.

Crack Repair

What Caused My Acoustic Guitar To Crack?

A washboard texture which looks somewhat like corduroy is one of the first signs of dryness.

It is very important that you know how to recognize this and what to do about it should your guitar start to show these signs of dryness.

In the picture below the soft spruce top has lost a great deal of moisture and the dark grain lines now stand prominent, the ridges are noticeable to the touch.

Cracking is likely if the problem isn't addressed and its dry season continues.

A dried out spruce top often resembles corduroy.

Tops are build with radius or arch. As the instrument dries out this arch will flatten and the washboard texture may already be noticeable.

If humidity is low and the instrument continues to dry out the arch will flatten and can become concave when terribly dry.

If your instruments top begins to dip and become concave without cracking you're pretty lucky, now is the time to begin humidifying.
The majority of instruments that are truly dry will crack the top first , very dry instruments can also split along their sides or seam lines.
On one of those, a good rap or bump to the side can result in the side splitting wide open, not a pretty sight.

Common Signs of Dryness

- Washboard texture on top
- Lower action due to a flatter (dropping) top
- Sharp fret ends
- Loss of top or back arching

Straightedge reveals concave guitar top.

Repairing Cracks

While some cracks are relatively easy to repair it's important to realize that are often a one shot deal. When repairing cracks it is essential that the separated halves are well aligned and the work is done cleanly. Reversing a bad repair is far more difficult and expensive than having it done correctly to begin with.
When repairing most cracks I like to have a caul on the inside and outside of the instrument that keeps both sides of the crack aligned while gluing.

Cracks Near The Pickguard

Several manufacturers employed the process of attaching the pickguard directly to the bare wood of the top before spraying the instrument.
Unfortunately these shrinking celluloid pickguards can cause a problem. If they maintain a good grip on the top while shrinking it places formidable stress on the top. If the pickguard shrinks considerably a crack can develop on either side of it.
To repair these cracks the stress must be eliminated by removing the pickguard and reattaching or replacing it. In an effort to avoid a repeat, and keep the new adhesive from pulling up wood fibers if removed again, this bare area of wood beneath the guitar is usually sealed with finish. View a Martin Pickguard crack repair.

Finish Repair

The real challenge to repairing most tight cracks is primarily with the finish. Stripping and refinishing the entire panel to render an invisible repair on a small crack would be overkill to say the least. Depending on the crack, finish repair may not be advisable or necessary.
Glued cracks still leave a small valley in the finish. When repairing cracks it is usually a two part process; repairing the crack in the wood, and then repairing the finish.
When repairing lacquer finishes a new lacquer "fill" is placed in the finish crack. This lacquer fill will begin to shrink almost immediately and a small depression is likely to appear, even after weeks of patient waiting. Lacquer is very high in solvents and it shrinks quite a bit. For this reason small chips, sink marks and cracks can reappear after a flawless repair days or even weeks after it has been done. I try and educate my customers to the nature of wood and lacquer so they understand what is possible.

Taylor guitar damaged by impact.
Photo of completed repair

Cracks That Will Not Close

More often than not, cracks that have spread open and will not close with humidity are spliced, filled with a inlay of wood. This dilemma is usually only found on older, very dry instruments, perhaps something that was left in a very poor environment. But there are other causes that can create the need for a splice, like something that has been damaged and wood is now missing or an area that is under so much stress that closure is not possible.
A splice is an insert of wood, like a filler strip, that is inserted into the area that is open. If the crack that is being repaired does not follow a straight line but runs across the grain the splice is much wider as a symmetrical splice must be used.
What about just filling the crack with putty, wouldn't that be easier?Oh my, would it! However, I don't do it. Putty and wood filler is not an acceptable repair method in most cases. While there are obviously some repairs that may require it, wood should be replaced with wood. Putty will shrink and usually just doesn't look right. Obviously on something very inexpensive, splicing or wood replacement can easily exceed its value.

My Guitar Cracked, Now What?

If there is any chance that the crack is related to dryness you shouldbegin humidifying the instrument.
The best time to repair a crack on your instrument is before it has time to accumulate dirt and grime or worse, run like a bad pair of panty hose! (Sorry guys ...a Pinto on Nitrous?) If string tension puts stress on the crack you should remove it immediately.

Cracks that go un-repaired can sometimes cause more serious issues, especially if it causes the wood to warp and twist out of alignment.
If string tension stresses the area of the guitar that is damaged or cracked it should be removed until a repair can be made.

Cleats

Cleats are normally made from the same material as the panel which they are reinforcing. While there are some repairs that require reinforcement, I avoid cleats unless absolutely necessary, especially on clean cracks. As I point out to my clients, every guitar has a top and back crack...tops and backs are made from book matched wood, two pieces of wood glued together down the center. This is a glued seam and is not cleated. (The center strip used over many back center seams is there to reinforce the area when the back is routed for a center strip.)

Cost

Whether caused by impact or dryness, cracks can effect the braces as well. The alignment, finish damage and ease of closure all contribute to the overall cost.
I offer free estimates to those desiring to have them repaired, I can not offer estimates based on pictures alone.

Fingerboard Care & Repair

Fingerboard Care

Unfinished Fingerboards

Most fingerboards are not painted. (Rickenbacker and Fender Maple boards are among the exceptions.)
On **unpainted** fingerboards, using 0000 steel wool is a popular choice. It does however come with downside, lots of tiny hairs shedding and making a mess. Naphtha has also been used, put I personally find it's cleaning properties pretty limited.
I prefer to use Dunlop's fingerboard cleaner. It is sprayed on and does an excellent job of cleaning even filthy fingerboards. I was pleasantly surprised the first time I tried it out on a 50+ year guitar with decades of caked on dirt. I would recommend using it with a disposable rag (I like the blue Scott shop towels).
After cleaning the fingerboard micro fiber cleaning clothes can be used to lightly polish the frets. Steel wool will also do the trick, but again, makes a bit of a mess.
When using steel wool on a fingerboard remember to avoid contact with any painted surface and protect pickups from the wool hair.
After cleaning an unpainted fingerboard, follow up with some fretboard oil to restore some moisture. Let it soak in for a moment and then remove excess with a cloth.
Fingerboards may require oiling periodically (every few months) but I would not recommend a weekly oiling. Fingerboards that are saturated with oil can become greasy which makes them attract dirt.

Painted Fingerboards

Painted fingerboards are cleaned in a similar manner to the finish on the instrument. Remember that nickel frets will turn your cloth black when polishing. Avoid contaminating areas of bare maple with polish or your blackened cleaning cloth.

Fingerboard Repair

Chipping

Old or brittle fingerboards can turn a simple refret into quite a tedious job. I have re-fretted enough 80+ year old boards to know.
Although chipping is unavoidable on some fingerboards, it can and should be repaired.
This should **never** happen and was caused by incorrect removal of the frets. Yikes!

Cracks

Fine line cracks can develop in the fingerboard and stretch a distance of several frets. These are often spotted when cleaning the fingerboard and can be an indication that the instrument is dry and in need of humidity.
If you see cracks develop in the fingerboard make sure the instrument is properly humidified.
After properly cleaning the fingerboard to remove dirt and oil, fine cracks can be filled with wood dust and adhesive. The fill is then leveled and the board is lightly sanded and polished.

Common Finish Issues

Lacquer Checking / Crazing

This is an extremely common, somewhat expected condition on older instruments with lacquer finishes. Checking will vary according to the extremes the instrument has been through. As an instruments wood expands and contracts with moisture content stress is placed on the finish.

Heavy finish checking /crazing

The lacquer itself is put thru allot of stress as this takes place and the finish may develop checking/crazing is a result of this movement. Checking looks like very fine finish cracks running in all directions.
Extreme and sudden temperature changes can also cause finish checking, regardless of the instruments age.

Can I avoid checking?
If you travel with your instrument and it is subject to severe temperature changes, you should allow it to acclimate to room temperature **before** opening the case. When instruments are shipped to me they are left unopened until I am sure the contents have had the opportunity to warm/cool to room temperature slowly.
You should also insure you are properly humidifying your instruments to avoid sever dryness. See my humidity article for more information.
Can you repair finish checks? Because checking is a common occurrence on vintage instruments most should avoid refinishing as it is likely to happen again. An additional deterrent would be the negative effect on value.

Yellowing Finish

Instruments finished in nitrocellulose lacquer not only tend to craze with greater ease than the newest catalyzed finishes but they also yellow with age. An instruments finish can consist of a color coat and clear top coat or simply a clear coat.
With age this clear top coat begins to turn yellow. That means a white guitar may eventually turn yellow and, since blue and yellow make green, older blue instruments can eventually turn green. This phenomenon is a simple fact of life and a natural occurrence with aging lacquer.
While it's true that UV rays may accelerate the process (just peak under a pickguard), nothing can be done to stop nitrocellulose from yellowing. In fact, like crazing, it is a common and expected occurrence.
Can you sand off the clear coat to remove the yellowing? As simple as that may sound the answer is no. Trying to sand off just the top clear coat and not damage the color is a lesson in futility.
That being said, when I was young I attempted to sand off a refinish color to reveal the original finish on a vintage Fender Strat. What I found after days spent removing small amounts of finish was that the original coat had been sanded thru in areas as it was prepped for the refinish. Futility only a do it yourself er would attempt!

Soft, Gooey Finish

Lacquer is the most common finish used on vintage instruments and while it has great properties for touch up it can be damaged with certain solvents.

Lacquer is a solvent based finish and can be damaged by contact with acetone and lacquer thinner. It can also be damaged with prolonged contact with water and denatured alcohol.
One reaction that many are unaware of is lacquers nasty reaction to prolonged contact with vinyl. Vinyl will soften lacquer to a point that it will roll up under your fingers. Refinishing of the effected area is necessary.

Peeling Paint (Delaminating)

Different manufacturers have had issues with de-laminating finish at different times. De-lamination occurs when the top coat can not adhere to the underlying sizing or sealer. Much like the white Dodge's we see driving around with large patches of exposed gray primer, the top coat let's loose and chips off with little effort.
Because this is an adhesion issue, overspraying without stripping to bare wood often results in a repeat. The surface must be re-prepared for refinishing.

Cloudy White Finish

Finish clouding on peghead of Alvarez guitar.

Clouding refers to a milky white coloring that makes the clear coat far less transparent and foggy. I have only witnessed this phenomenon on inexpensive poly finished instruments.
Due to the time and cost involved to strip and refinish one of these instruments it is a condition most are forced to live with. Because the clouding is in the finish, buffing and polishing have no effect.
This is not usually seen when the instrument is new but develops over time. While I have ideas as to the cause I do not know for certain.

How Do I Remove Scratches From My Guitar's Finish?

Obviously scratches are a part of life, but on occasion we want to spruce up our instrument and erase some of the wear and tear associated with playing.

Buffing scratches is an option if they don't go too deep. When buffing scratches out, quite literally, finish is being removed until you are at the bottom of the scratch, making the finish a smooth flat surface again. For heavy scratches, wet sanding often precedes buffing.
While this is completely reasonable for very fine scratches, you can quickly guess why attempting to buff out a very deep scratch can end in disaster.

On instruments with color, a clear coat sits atop the color coat. If too much clear is removed you may buff into the color coat. Doing so leaves a hazy dull ring around the area of transition.
If the instrument is merely clear coated, the same applies, sanding or buffing thru the finish will leave bare wood exposed.
Drop filling a scratch, leveling the fill with the surface and then buffing the instrument is another technique. However, when drop filling lacquer and other finishes, the fill normally shrinks with time and a dip is still seen even after a spotless repair.
Glazes and waxes attempt to "fill" scratches and claim to make them less noticeable. However, coming from an ex-body shop manager and car detailing buff, it isn't as easy as all that.
A good rule of thumb here is, if you can hear your fingernail click when running it across the scratch, it is probably too deep to wet sand or buff out.

Refinishing Vintage Instruments

When dealing with vintage and collectible instruments it is usually in the best interest of the owner to preserve its originality as much as possible, monetarily speaking. As is common with other antiques, refinishing is detrimental to the value often associated with rare or vintage instruments. Generally speaking, the only time I would recommend refinishing a vintage instrument is when damage is severe enough that it is simply required or when it has already been refinished very poorly as seen in this photo.

This Martin D-28 appeared to have been painted with a brush.
View same instrument after refinish.

Types of Finish Repair

Touch-Up

When I use the term touch up I am usually referring to a relatively small area that can be repaired by brush work (drop filling finish into a chip or valley) or air brushing a small area.
Lacquer which is drop filled by brush must be wet sanded and polished in order to render the smooth, glass like surface one expects to see.
Of course the most difficult part of touching up chips or scratches is not necessarily the application of the lacquer but the blending of new with old. It is truly an art form in many respects and one must aptly judge the thickness of the finish they are dealing with in order to avoid sanding or buffing thru the finish.

Lacquer Melting

Flaking, brittle lacquer finish that is easily removed by simple contact can sometimes be stopped by amalgamating (re-melting) the finish. Finish that has separated from the wood can sometimes be reattached by this method. Top coats are normally diluted with a retarder and thinners that soften the original coat and allow the new coat of finish to melt into the existing finish.

Overspray

Overspraying refers to a technique whereby a new lacquer top coat is sprayed over the existing lacquer finish without completely removing the original finish.

Aging

It is not uncommon to run across instruments who's binding has begun to crumble and literally fall off. With this type of deterioration it is necessary to replace the binding and of course when we do so the new binding stands out like a brand new penny. Solution...we age it. We can age binding by applying a top coat of tinted lacquer to render the yellow hue we normally see on vintage instruments. On most instruments the yellow tint you see on the binding and other areas is simply the result of yellowing lacquer. Once the lacquer is removed you are likely to find white binding (assuming it was white when new). That's why worn areas often differ in color. Other repairs may also necessitate this synthetic aging technique.

Non-lacquer Finishes

When applying overspray one of the most crucial elements to success is adhesion. It is absolutely essential that our new top coat bite into the existing finish. That bite is one obstacle we often run into when trying to overspray finishes other than lacquer. Many of today's newer finishes are so hard and impervious to chemicals that overspraying them may not be an option. The factory can advise you of your finishes repair techniques.

Cost

Refinishing is usually cost prohibitive on anything by high quality, valuable instruments. A professional refinish requires neck, bridge and pickguard removal. These parts are not masked around as finish would pool at the edges and look unprofessional.

> **As of August 2010 the Martin Guitar factory charged more than $900 for a complete refinish of the body of a D-28.** (Neck not included)
> **Likewise, the Taylor factory charged $800 for a complete refinish of a gloss finished body.***For exact prices contact the factory.

You can easily see how much more one pays for man hours than for production line work. In some instances the cost to refinish an instrument exceeds it's replacement cost. This comes as quite a shock to most, but can be more understandable once the process is viewed.

Lacquer Repair Challenges

Lacquer is very high in solvents and as a result it shrinks quite a bit. For this reason, the lacquer used to fill a chip or crack can continue shrinking weeks after a nearly invisible repair. Realize that I am being quite picky to say that I can see the repaired area but I try and educate my customers to the nature of lacquer so they know what to expect.

Refretting Guitars

Step 1: Fret Removal

I generally use heat when removing frets. It's a good way to determine if glue was used during installation and facilitates easier removal. In order to apply the heat only the to frets crown I use a wide tipped soldering iron. I like to file a small notch in the tip so it can seat on the crown without sliding around.

In order to pull frets out cleanly, I use a small pair of end nippers that I have filed to flatten the head which rest against the fingerboard. Instead of pulling frets out, I am "pinching" the out. The thin blades of the end nippers slide beneath the crown of the fret and gently wedge them upward as I walk the nippers from one end of the fret to the other, never lifting

the pliers but using the wedge effect.

Older, brittle boards require patient care as the tang of the frets tends to pull small chips free as the fret is lifted from the slot. When you've re-fretted as many 80 year old fingerboards as I have, it isn't a question as to whether they will chip, it's how badly. Removing the frets correctly means less repair is necessary after removal.

> Heat can damage and destroy celluloid binding and inlays. It is critical that the irons tip touch nothing but the fret crown.

Chip Repair

Some of you have witnessed less than professional fret jobs that left the fingerboard littered with chips. While chip out can not always be avoided it can and should be repaired. Amongst my favorite techniques is using some sawdust sanded from the fingerboard mixed with Duco cement. Fills are then block leveled and further fingerboard prepping can begin.

Step 2: Prepping The Fingerboard For Frets

Sanding The Radius

With the frets out and the neck adjusted flat it can now be checked for trueness and planed if necessary. To properly plane a neck straight I feel the best sanders to use are close or equal to the

length of the fingerboard. Longer planes and sanding blocks cover a greater surface area and make equal removal of material far easier.

> A **radius gauge** is an easy way to measure the fingerboard's radius and choose the correct caul for sanding.

After planeing, if necessary, I switch to lighter grit sandpaper and a sanding caul that is radiused to match the intended fingerboard radius.
A long straightedge is used to ensure the neck is straight and no high/low spots remain.

Cleaning The Fret Slots

When working on a newer instrument I may use the air hose to blow the sanding dust from the slots. On delicate vintage boards air pressure is enough to blow chips out of the board and is best avoided.

A feeler gauge can be used to measure the width of the fingerboard slot and determine the fret tang size needed. While nearly everyone knows that fret wire comes in many different crown sizes (short, tall, wide, skinny) some are unaware that it also comes with different size fret tangs. Using the correct tang size is essential and should not be overlooked.

Fret Tang Choices

Using a fret tang that is too small for the fret slot can cause frets to quickly loosen and lift. It can also weaken the stiffness of the the neck as the lack of fret slot compression allows the neck to bend more easily.
A fret tang that is too large can add too much compression to the neck. When large enough, this can actually back bow the neck as it adds mass to each fret slot... a technique I use to strengthen and straighten older necks with no adjustable truss rod.
The fret slots on unbound fingerboards can be cleaned with a traditional fret slotting saw of the appropriate size. Bound necks require very short bladed saws that will fit between the binding or, my favorite, a small hook tool that nicely scrapes the slot clean.

Changing The Fingerboards Radius

To some extent the original radius can be changed if desired. We are however limited by the fingerboards inlays and overall thickness. A drastic change to the radius could require so much wood removal that we endanger the inlays or thin the board.

Compound Radius vs Single Radius

A "compound radius" means the board starts out with a tighter radius at the nut and gently tapers into a flatter radius.
A fingerboard with a single radius is shaped the same from the nut to the heel.
While we all have our preferences as far as fingerboard radius is concerned I will through out a few tips, but mind you YMMV.

Because a tighter radius produces a rounder fingerboard, chord players and those with hand problems may enjoy the tighter radius of 7.25" or 9". The biggest problem with a tight radius occurs when attempting a substantial string bend with average to low action. The string will contact the fret and fret out or buzz. If your a heavy string bender avoid the vintage 7.25" radius or prepare to meet high action.
A radius of 16" or flatter may be preferred by those playing lead. These are generalizations of course.

> **How do I know which radius is best for me?** Take the instruments that feel most comfortable to you and measure their fingerboard radius. (Or check their specs. online.) If there's a consensus, you've dialed it in. If not, it may not matter much to you.

Step 3: Fret Wire Preparation

Bending Fret Wire

Some fret wire is sold in straight lengths while others come in a coil. Before pressing the fret wire into the prepared fret slots it should be cleaned with Naphtha or similar solvent to remove oil.

It is then sent thru a Fret Bender to bend the radius to match the fingerboard. Nickel fret wire wants to "spring" when being pressed into the fret slots and it is usually necessary to slightly over radius it.
Stainless steel fret wire is another story. Because it is rigid and retains it's original arch it should be bent to match the fingerboard exactly.

Fret Wire Size

For more information on fret wire size and materials, check out my Fret Wire page.

Step 4: Installing New Frets

Cutting Fret Wire

When the fingerboard has **no binding** each fret is cut slightly longer that the fretboard's slot and clipped flush with the fingerboard's edge**after** installation.

Cutting Frets For Bound Fingerboards

Bound fingerboards require far more work. Each fret must have it's tang cut to fit between the binding, leaving the crown to overlay the binding.
Once the tang has been cut with **fret wire nippers**, the remaining bur is filed so the crown can sit flush against the binding.

The fret wire's tang is clipped and the remaing bur filed away.

Gluing Frets In

Glue is used when necessary. A new fingerboard rarely "needs" to have it's frets glued in as using the appropriate fret tang will enable the fret to grip the board nicely. Older, brittle boards or one's that have been re-fretted numerous times, some, less than professionally, may require gluing. Some boards simply don't grip the fret wire as intended and feel a bit soft when installing frets...all reasons to be safe rather than sorry. (Maple, I'm talking to you.)
An instrument that is subject to low humidity and less than ideal care may also be a candidate for glued in frets. Subjecting an instrument to dry climates can cause shrinking and swelling of the fingerboard which can cause frets to spring free. While this problem is best addressed by taking proper care of the instrument, if it's a known problem glue adds a little insurance.
Because I use the **compression method** I will either be tapping the frets in with a fretting hammer or pressing them in with a arbor press.
To avoid dinging the new fret when installing them I use a fretting hammer with a plastic tip.

The arbor press is equipped with "feet" which are machined from brass and are shaped to match the fingerboard's radius. With the fret sitting atop the slot the arbor press pushes the fret into the slot.

Beveling The Fret Ends

Frets are slightly beveled on the edge.. Manufacturers vary a bit on how they bevel and round the fret ends, but the object is the same....no sharp edges!

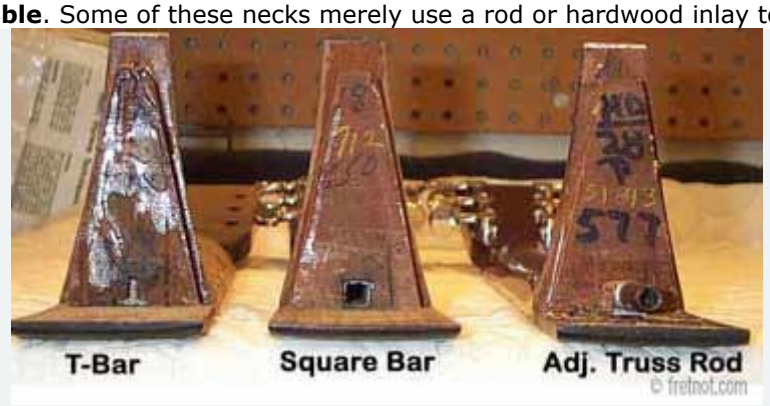
Can someone over bevel the fret ends? Yes! In severe cases the outer E strings may lie over or terribly close to this bevel and cause the string to roll off the frets edge when playing.
With the new frets installed, filed flush with the fingerboards edge and properly beveled we can move onto leveling, re-crowning and polishing them.

Continue to Fret Leveling

Special Considerations

Necks Without Adjustable Truss Rods

When tension is placed on the neck it is normal to see some amount of relief or upward bow. When the relief becomes excessive we tighten the truss rod to counteract it and draw the neck straight again. **What if the guitar has no adjustable truss rod?**
While most instruments built after the turn of the century do indeed have a truss rod, not all of them are **adjustable**. Some of these necks merely use a rod or hardwood inlay to stiffen the neck.



Comparison of Truss Rod Types
The T-Bar and Square Bar strengthen the neck but are not adjustable.

When an instrument without an adjustable truss rod suffers from too much relief or a permanently bowed neck, planeing and refretting can often improve it's playability. Even after planeing a neck flat it may still bow a considerable amount under tension if the neck is weak. In an effort to stiffen it, fret wire with oversized fret tangs can be used for additional compression. Because this is just as much experience as it is technique, the correct size tang must be chosen to insure the neck does not end up back bowed.

Rubber Necks

There are necks that I can flex with my hands, some can actually see them flexing while playing. While planeing and refretting on of these may improve them somewhat it can be a risky adventure. A neck that shows itself to be weak in this manner is not likely to undergo a radical transformation simple because it has been re-fretted with oversized tangs. Careful examination is in order here, as well as an up front, honest conversation with the owner. Putting money into a refret when the neck is in serious trouble can be hopeful thinking.

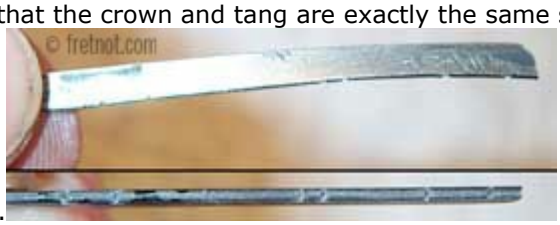
Gibson And Those Binding Nubs

If you look closely at the frets on a bound Les Paul you can see a small "cap" of binding at the end

of each fret. We've referred to these as nubs, nibs, fret caps...
When these instruments were manufactured the board was fretted, the frets where filed even with the edge of the board and **then** the binding was attached.
The binding, which sits proud of the fingerboard is then scraped level with the fingerboard leaving the small nub of binding at the end of each fret. Many like the feature as it prevents strings from catching under the ends of the frets when they are rolled off the edge of the fingerboards (which can certainly be prevented without them BTW).
When refretting an instrument fretted in this manner, those nubs disappear while sanding the fingerboard. It is unavoidable when the entire fingerboard is being re-fretted as the fingerboard must be resurfaced to prepare for the new frets.
When performing only a partial refret on this type of neck, the nubs are usually preserved but more time and expense is incurred to precisely match the shape and fit of the old frets. I think it's fun and enjoy the satisfaction of preserving the look of the original, I would not however, enjoy doing that on all 22 frets of a Les Paul. lol

Bar Frets

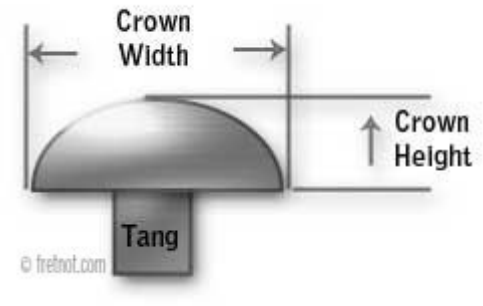
Bar frets differ from traditional fret wire in that the crown and tang are exactly the same size,



unlike the mushroom shape of today's wire.
Traditional fret wire can not be used to refret an instrument that has bar frets due to their size. Today's fret wire tang is not large enough to fill the fret slot of a fingerboard who originally had bar frets.
Sources for bar fret wire pop up from time to time but I no longer have it in stock and do not offer it. You can see picture's of a bar fret refret here.

Guitar Fret Wire - Types and Sizes

The position of the fret on the fingerboard indicate the location of the next note, as a result, their positioning and the shape of their crown are crucial for good intonation.



Guitars may require refretting for many reasons, the most obvious being to replace worn frets or change their size.
However, refretting is also necessary when correcting neck issues that require planeing of the fingerboard.

Fret Wire Specs

Fret Size

- **Crown Width** (Popular size range .078 - .110)
- **Crown Height** (Popular size range .035-.055)
- **Tang**

Fret Material

- Nickel (18% Nickel-silver)
- Soft Nickel
- Brass
- Stainless Steel
- EVO Copper Alloy (nickel free)

Vintage instruments sometimes used a fret wire which is uniform in size (flat instead of mushroom shaped.)
These are known as bar frets.

Choosing The Right Fret For Your Guitar

There are many choices available when it comes to fret size. Most players however will develop a preference for size depending on their style. Fret wire can be measured when the size is unknown.

Tall Frets

Taller frets (higher than say .045) are often favored by string benders. Their height make it easy to push the string when bending. They also produce a clear note without allot of pressure. The downside is, hard fretters tend to bend the string sharp.

Short Frets

You either love these or hate them I think. They have a barely there feel to them. Think fretless wonder. The string really drags against the board when bending.

Skinny Frets

Fret crown widths below .080 is what I would call a skinny fret. These are often seen on vintage guitars, banjos and mandolins. These are good on intonation, but can wear more easily.

Wide Frets

Wide fret wire of .100-.110 is most often used on electric guitars and basses. These generally wear slower than skinny frets. Excessive wear on wide frets can throw intonation off.

Common Fret Problems

Wear

Strings wear grooves in the fret's crown.

Most players can easily spot the grooves worn in frets by string contact. As grooves grow deeper, buzzing may occur because the string now sits lower and contacts the next, higher (less worn) fret. But wear is not always seen as small grooves. Heavy string benders will also notice that the once round fret crown has flattened which can alter the string's contact point and effect intonation.
Worn frets can be leveled and dressed only if sufficient fret height remains to permit filing.

Sharp fret ends

When the edges of frets suddenly become sharp (no recent fret work) it is usually an indication that the fingerboard has lost moisture and shrunk.
When humidity levels drop the fingerboard can shrink enough to leave the edge of the frets now slightly extended. A fret dressing can smooth the sharp edges but the instrument should also be properly humidified to prevent other damage.

Frets are too high

Some new instruments come with fret wire measuring .055-.060 high. Higher frets are not for everyone, especially those with a firm fretting technique which is likely to cause notes to go sharp. Frets can be filed to reduce their overall height and re-crowned. View my article on fret leveling for details.

Frets are too low

Speaking of fretless wonders...wow!

Not all wear appears as grooves in the fret. Many times the wear is evident by the lack of roundness to the crown.

String bending acts like a file continually filing away at the crown of the fret.
In an attempt to correct fret height inconsistence, frets can also be filed too low when a less experienced craftsmen is attempting to level the frets.

Loose / Lifted Fret

The fret's tang can loose it's grip on the fingerboard and spring loose which causes it to stand proud of the surrounding frets. When this happens, the note prior to the lifted fret will normally buzz against this high fret.

Loose fret ends often catch
the treble E string when bending.

Loose frets can be secured and leveled when height permits. If many are spotted refretting is usually necessary to address the cause of the problem.

Gaps Under Frets

On guitars with bound fingerboards, shrinking of the binding can produce a gap large enough to catch the treble E string when pulling it over the edge. If only a few our present I will fill the gap to eliminate the problem. If the binding shrinkage has introduced gaps at every fret, the board should be re-radiused to eliminate all gaps and re-fretted.

Glues Used In Guitar Repair

Aliphatic resin is amongst the most popular woodworkers glue used in instrument building and repair. Titebond Type 1 original formula and various other brands such as LMI and Garrett Wade which are available in both white and yellow.
This is the glue most factories use to assemble and repair instruments and it is easy to work with. Unlike Hide glue, it is ready to use straight from the bottle. Woodworkers glue is water soluble, has longer working times than Hide glue. It softens with heat and is very strong.

Titebond Glue

I use Hide or Aliphatic glue for nearly all wood to wood repairs including gluing bridges, bridge plates, braces, necks, most cracks and fingerboards. For the novice or do-it-yourself er this is going to be the glue of choice.
On instruments most glue joint failures are hardly ever related to the glues strength. The most common culprit is insufficient glue, heat exposure or poor surface to surface contact. Glue is not a filler and should not be considered a fix for a poorly fitting joint. When repairing loose braces or bridges there is no need to seek a stronger adhesive as carpenters glue is more than ample.

Most glue joint failures are hardly ever related to the glues strength. Titebond or other aliphatic glues are more than strong enough to do the job.

Hide Glue

Hide glue is one the oldest glues used in instrument making and repair.
This glue is sometimes frowned upon because it is a little high maintenance. Hide glue is purchased in a dry form, mixed with water and then heated before use. It must be kept hot to prevent it from gelling and this requires a glue pot or other means to produce the heat necessary. There is no denying that hide glue stinks!
Hide glue will stick to itself, it is water soluble, and does not creep like aliphatic glue.
There is/was an instant Hide Glue available but you want to steer clear of that.

Super Glue (Cyanoacrylate)

Super glue happens to be an indispensable tool in this trade and it is also a very dangerous one in the hands of some.

Unfortunately someone used superglue on loose braces

I use super glue primarily when repairing things other than glue joints. In other words, super glue is never used on loose braces, bridges (when they're wood gluing to wood), end pins, open seams, pickguards etc. Its most popular use is fingerboard cracks, bridge cracks, inlay repair and the like. It can be colored and used in many applications but because it is permanent it is not suitable for wood to wood glue joints.
Another dangerous but wonderful use for super glue is finish chip repair on some of the newer finishes. It is clear, dries hard, shrinks very little and is sandable, a perfect candidate for finish repair and used by most factories.
Permanent adhesives like super glue and epoxy should not be used to glue bridges, braces, necks and other instrument glue joints/seams.

Epoxy

Most of the warnings that come with super glue apply to epoxy. It is a permanent adhesive that you must sand to remove once hardened. Like super glue it should not be used on joints and seams.
Epoxy can also be tinted and used to fill chips in bridges, fingerboards and the like.

Guitar Intonation

Why A Guitar Won't Play In Tune

My guitar does not play in tune, even after I know I've tuned it correctly. Some chords sound in tune while others don't.

This article details the reasons a guitar will not **play** in tune. To view information about "**staying**" in tune, please refer to my article ontuning issues.

Checking Intonation

To check intonation you will need an electronic tuner. Tune your instrument to pitch and fret each string naturally at the 12th fret.
If notes played at the 12th fret are dramatically sharp or flat, the intonation may require correction.

Things That Can Cause Poor Intonation

- Physical placement of saddle (this determines the string's length)
- Wear on the string's contact points (frets, nut, saddle)
- Very tall frets
- String gauge
- High Action (too much distance between the fret and string)
- Playing technique

High Action

Very high action (string height) causes a string to be stretched as it is fretted. In the same way that bending a string causes the note to become sharp, pressing a string down when the action is quite high will also cause string stretch.
When string height at the nut is too high, chords and notes in the first position are often out of tune.
Correction: The instrument should be properly set up.

Excessive Neck Relief

A neck with far too much relief (bowing in the neck) not only shortens the distance between the nut and saddle, it raises the string's distance from the frets.
Correction: Adjust the truss rod to obtain proper neck relief and set up if necessary.

Leaning Saddle

The saddle should sit firmly in the bridge. A loose saddle can lean forward, shortening the string's length and sharpening the intonation.
Correction: Replace the saddle for proper fit.

Worn Saddle Crown

Deep notches in the saddle may change the string's length.
Correction: Replace or re-surface the saddle.

Fret Wear

Frets that are badly grooved or have flat crowns will also throw off intonation as the string's length is changed.
Correction: Worn frets can be leveled and re-crowned to remove the grooves. Severely worn frets may require replacement.

Fret Height

Instruments with very tall fret wire can play incredibly sharp if the string is fretted hard.
Using an electronic tuner fret a note and watch the tuner as you apply more or less pressure to the string to view the effects.
Correction: If the fret crown is very tall, fret leveling and re-crowning can reduce it's height.

String Quality & Gauge

String quality has really only been an issue for my clients when purchasing no name strings from auction sites. While seemingly cost effective some are notorious for bad intonation.
When re-stringing an instrument that has been properly set up it is important to use the same string gauge. Saddle compensation, neck relief and action have all been set for a particular string gauge. Increasing the tension of the strings can cause sharper intonation.
Correction: If the instrument played in tune before and no changes have been made to the instrument you may wish to change strings first.

Saddle Placement

The string is always resting in the nut's slot and on the saddle's crown. Changing the position of the saddle or nut will therefore change the length of the string.
A string that is too long will cause the intonation to be flat at the 12th fret.
A string that is too short will cause the intonation to be sharp at the 12th fret.
Correction: The saddle's crown may need compensation or, in more severe cases, the bridge saddle slot may need to be moved.

Fret Spacing

I hate to mention this as I fear far too many people will jump to this conclusion in error, but I still encounter this on occasion. This is generally seen on inexpensive imported instruments and some vintage pieces with hand slotted fretboard's.
Correction: Fingerboard replacement.

Playing Technique

Some players have a rather powerful fretting technique in which they place excessive pressure on the strings when fretting. If the instrument happens to have fairly tall frets the combination often results in sharp intonation.
To illustrate, use an electronic tuner and play a note using varying fretting pressure. The tuner will show you how your pressure effects the note.

A Word About Scale Length

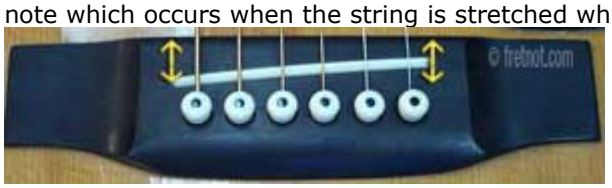
Common Scale Lengths*

Martin Dreadnought 25.4"
Martin 000-28 24.9"

Taylor Grand Auditorium 25.5"
Gibson J-45 24.75"
*some editions may vary
When trying to determine the **Scale Length** on an instrument measure the fingerboard from it's start (where it touches the nut) to the center of the 12th fret. Double this number to arrive at the Scale Length.

Scale Length can be determined by measuring from the end of the fingerboard, to the center of the 12th fret and doubling it.

In order to compensate for the sharpening that occurs when fretting notes up the neck, additional string length is added to the scale length in order to provide better intonation.
If you look at the saddle on a steel string guitar you will quickly realize that they are not in a straight line (with the exception of some classical guitars). Saddles are slanted because string length is actually added to the instruments scale length in order to off set the sharpening of the note which occurs when the string is stretched while being fretted.



The larger the string, the more compensation is usually necessary, thus the bass side of the saddle will be further from the fingerboard than the treble side.

Adjusting Guitar Intonation

The first step to correcting your instrument's intonation is to address any issues that can cause intonation problems. If you haven't done so already take a look at my list, most new intonation problems will be caused by one of these issues. Knowing the cause is the first step to fixing the problem.

Check Your Intonation
To check your guitar's intonation you will need a tuner preferably, a chromatic tuner. Tune your instrument to pitch and fret each string naturally at the 12th fret. This note is one octave higher than the open string note and should be in tune (neither flat nor sharp.)
If notes played at the 12th fret are dramatically sharp or flat, changes to the strings length and position of the saddle (or shape of it's crown) may be necessary.
When correcting poor intonation on an acoustic guitar I use an electronic tuner to evaluate the strings tuning at the 12th fret. I record this information for reference while making adjustments. Only after any issues that can contribute to poor intonation are corrected do I may further adjustments to the nut and/or saddle.

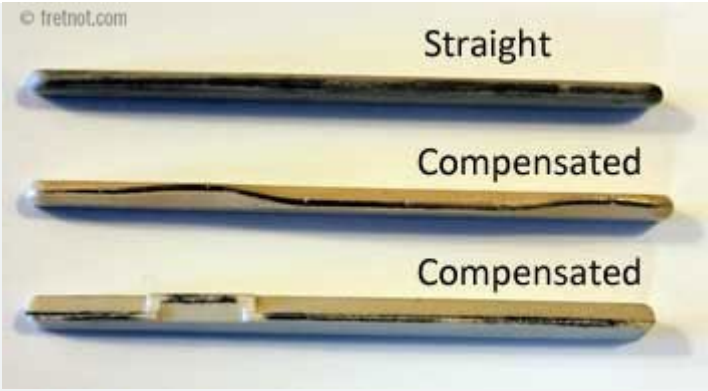
Installing A Compensated Saddle

Installing a **pre-made** drop in compensated saddle is usually a simple upgrade. If your instrument has already been set up properly you can use your original saddle as a reference when sanding the height of the new one. If the instrument has any playability issues a set up should be performed along with the saddle upgrade.

Most saddles are either 3/32" or 1/8" wide. When purchasing a replacement, height can be filed by sanding.

Graph-Tech®, makers of Tusq® brand saddles, provide a large selection of pre-made compensated saddles. See assortment in right sidebar.

When pre-made saddles are not available thru retailers or from the original manufacturer the saddle must be made from scratch. In these instances a saddle blank is used and shaped to fit.



Dark lines show the peak of the saddle and the strings contact point. Compensated saddles allow us to alter the individual string length and adjust intonation.

For instruments in need of extra fine tuning the shape of the compensated crown may need to be filed by hand, adjusting the length for each string individually. This is a more costly, time consuming method which may be required when good intonation can not be achieved using a pre-made saddle.

Installing Compensated Nuts

Compensated nut

Fretting a string stretches it and stretching a string will sharpen it slightly. To offset this sharpening,length is added to the instrument's scale length to compensate.

However, lengthening the string to compensate for fretted notes also lengthens the open string. Compensation of the nut can be achieved in different ways. Most have settled on a "shelf system" whereby the nut overhangs the end of the fingerboard which renders it slightly shorter. This eliminates the need to permanently modify the fingerboard's length by cutting it.

Earvana® is one example of a prefabricated compensated nut.

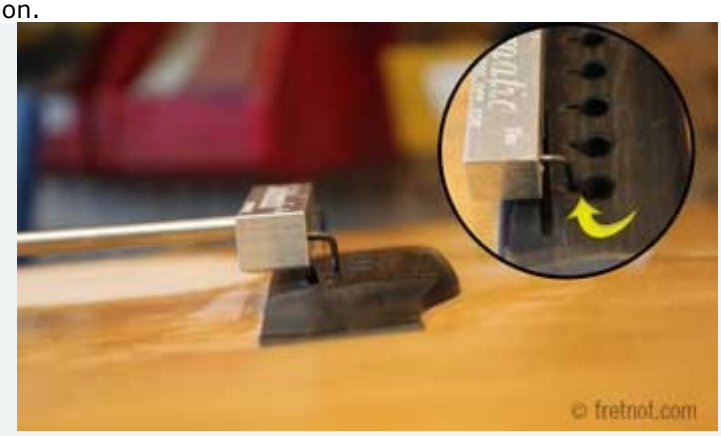
The Buzz Feiten Tuning system® is another method. Modifications are made to the position of the nut or fingerboard length. Intonation is then adjusted according to slightly offset tunings which are determined by string gauge, scale length and action.
My advice is to try the self-nut first, before modifying the fingerboard's length. I find it difficult to justify shortening the fingerboard of a vintage or valuable instrument.

Using Tuning Techniques

Just as there are several theories about ideal saddle and nut compensation, there are also different ways which we can tune our instrument.
One of the most popular methods is to use a chromatic instrument tuner to tune the open (un-fretted) strings. Other methods include using harmonics to tune or tuning 2 particular chords until they are in tune with one another. You can use whatever method you feel pleases your ear.

Correcting Saddle Location

Some instruments suffer from poor intonation because the bridge and/or it's saddle slot is not located properly. It is either too close to the fingerboard causing sharp intonation, or too far, causing flat intonation.



This instrument played terribly sharp due to a misplaced bridge.
The yellow arrow reveals the correct location for saddle placement.

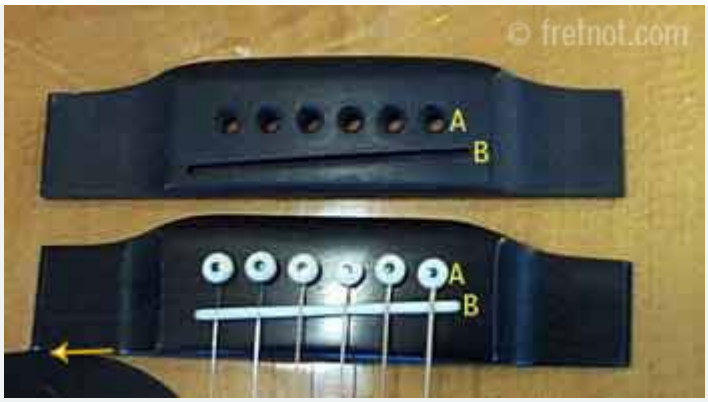
When possible (and appropriate), the original slot is filled and re-routed to correct the problem.

Ebony was used to fill the original saddle slot prior to reslotting.
When the correct placement is not possible a new bridge is made
to avoid placing the saddle too close to the bridge pins.

A bridge slotting jig serves as a guide for my laminate trimmer.

Bridge Replacement

On the bridge below, moving the saddle's position would have placed it too close to the bridge pin holes. Instead a new bridge was made.
It is quite common to see this scenario on Martin guitars built in the 70's (though they are not the only example).



Note the positions of the bridge pin holes and saddle slot.
The top bridge is an original, the bottom is the replacement.
Also of note is the proximity of pickguard to bridge.

Physically moving an acoustic guitar bridge to correct the intonation would leave behind a nasty unfinished area on the top which would be easily noticeable even with touch up. The alterations I make allow the bridge to sit on the same "footprint" and are only noticeable to those well acquainted with the original design.

In Search Of Perfect Intonation

Having every single note in perfect tune is beyond the abilities of many equal tempered instruments. There are in fact compromises and for a select few ...they may always be disappointed with the intonation of a fretted instrument.

Guitar Neck Problems

Bowed Necks (Excessive Relief)

The upward bow caused by string tension only becomes a real problem when it is excessive and unadjustable. The truss rod's main job is to keep the strings from pulling the neck into a exaggerated bow shape. A problem occurs when the bowing can not be controlled or adjusted by the truss rod. This happens when either the neck has no adjustable truss rod, the rod is broken or it has merely lost the battle with tension and is helpless to straighten the neck.

When appropriate, some necks can be planed and re-fretted with a fret wire which has wider fret tangs to encourage straightening and stiffening of the neck.

Twisted / Warped

Twisted Neck

Fingerboard has been planed to correct.

Unlike excessive relief (an upward bow of the neck) a twist occurs in such a way as to render the neck lower on one side than it is the other.

Very minor twisting may not create noticeable playing issues but more substantial deformities can cause fret out and buzzing.

Although twisted necks need to be evaluated to determine the best remedy, planeing is sometimes a remedy. Because wood is removed, the severity of the twist, fingerboard and neck thickness must be taken into consideration. It should also be mentioned that a new instrument exhibiting neck twist may continue to do so in the future, making the repair temporary.

Planeing an older neck, which has likely taken a set and stopped twisting is more favorable.

Breaks frequently occur where the peghead meets the neck.

Broken Pegheads

Without a doubt, the most vulnerable area of the neck is the point at which the peghead and neck merge. The angle of the peghead creates what is called "grain run out". This makes the area behind the nut more vulnerable than other areas.

Neck Volute

Adds mass to strengthen a vulnerable spot.

In an attempt to reinforce this area you will find that some manufacturers have used different methods. As seen on many Martin guitars, additional wood is left in place to thicken the area. This is known as a**volute.**

Others have chosen to make the neck out of more than one piece of wood. The peghead grain can then be closer to quarter and joined to the neck via scarf joint or other method.

Regardless of the methods used to build guitar neck's breaks occur.

Broken Peghead

Loose Necks

A set neck (glued on guitar neck) can come loose where it attaches to the body by impact, heat or failed glue joint. A loose neck can create high action and often leaves a visible gap between the heel of the neck and the sides. You should remove string tension if you discover the neck is loose from the body to prevent severe damage.

Because necks are attached to the body using several methods, the repair will depend on the cause.

This neck heel fractured after coming loose and being left under tension.

This Ovation's neck was epoxied in place. The glue held
but the actual wood failed (after impact), leaving bits of the heel still glued
to the dovetail joint.

Cost

Because most acoustic guitars are glued in place, the cost to replace an un-repairable neck is usually prohibitive on less expensive instruments.
A neck fitting on an instrument with a glued in dovetail and the cost of the replacement neck can easily run up a bill of $500 to $800 or more depending on the manufacturers pricing of the neck itself.
Bolt on necks which do not require as much labor are often less expensive to replace.
When a factory made neck is unavailable and a used, donor neck can not be found, custom replacement necks can be made by those offering this as a service, I do not.

Acoustic Guitar Neck Angle

Acoustic guitars may require a neck angle reset once the action (string height) has risen and methods to lower it have been exhausted.

Does My Guitar Need A Neck Reset?

Increased String Height Above Frets

Rising action can make an instrument difficult, even painful to fret. It also plays havoc with intonation.
Normally string height is lowered by performing a set up which makes adjustments to the truss rod, nut and saddle height. Eventually, however, some instruments arrive at a point to which no further adjustments are available.

Low Saddle

Guitars that are in need of a neck reset often have a very low saddle.
As the arch (belly) of the top rises thru years of string tension, the saddle is lowered to counteract it. Eventually the saddle is shaved as low as possible and the neck's angle must be reset to accommodate the new arch of the top.

> Very low saddles can diminish the volume and tone of the instrument.

Insufficient Angle

Plane of fingerboard passes below the top of the bridge indicating the need for neck resetting.

To assess the neck angle a long straight edge can be used. It is placed down the center of the fingerboard to the bridge.
As seen in the picture above, the arch of the top has risen and the bottom of the straight edge now falls below the top of the bridge, literally running into it.
Ideally the a straightedge, sitting atop the frets, should pass over the top of the bridge slightly when no string tension is on the instrument.

It's also important to note that, when possible, the neck relief (bow) is removed to provide a more accurate measurement of neck angle.

Causes

Many are under the impression that neck resets are necessary because the neck moves, in actuality that is rarely the case.
While necks do bow under tension, a properly working truss rod can adjust the amount of bow (relief) in the neck. **Neck resets are performed because the top's arch has increased, raising the string height.** We often call this "top belly".

> Neck resets are most often necessary because tension has caused the top to belly, which raises the bridge and string height.

Neck angle and neck relief are two entirely different things though both affect string height.
Neck Angle is the pitch (angle) at which the neck is set in the body and requires neck removal to change.
Neck Relief is the amount of curvature (bow/relief) in the neck itself and is controlled by the truss rod.
A neck with excessive relief can also create high action. When checking neck angle with a straightedge the neck should be adjusted straight if possible.

Other Considerations

Loose Necks

Guitar necks are normally bolted or glued to the neck block. If the neck should come loose from the block, string tension could pull it's heel out of the neck block, effectively changing it's angle. This condition would be readily apparent as a gap beneath the heel would be visible with tension is placed on the neck.

Loose Neck Block

A more difficult (and far more rare) issue to spot is a loose neck block. Because the neck is glued to the neck block it too must be securely glued to the top, back and sides. (Note some mortise style neck blocks may not touch the back.)

A neck block that has shifted can cause the neck angle to change when tension is applied and it moves within the body. This can occur when an instrument is left in a hot environment and the glue has softened. A thin **feeler gauge** can be used to check for gaps between the body and neck block.

Loose neck block

Under tension the neck angle would shift as a result.

I have also seen this on inexpensive instruments with neck blocks that have limited contact with the top and back. **Epiphone's® FT series**guitars with bolt on necks are notorious for loose neck blocks (as well as other issues).

Loose or Broken X-Brace & Worn Bridge Plates

Though rare, I have also seen a significantly loose X-brace's cause high action due to excessive bellying of the top.

The X-brace supports and stiffens the top as does the bridge plate. When a large section is loose it can permit excessive bellying, which raises the action.

Cost

Neck resets are generally only performed on relatively valuable instruments due to the cost. Along with resetting the neck angle, most instruments will require a complete refret so the fingerboard can be planed.

A neck reset with refret starts at **$650**.

Acoustic Guitar Neck Reset

Step 1: Loosening The Fingerboard Extension

Before removal of the neck begins the portion of the fingerboard which glues to the top must be loosened.

Heat is applied to soften glue beneath the small area of fingerboard that overhangs the top.

I personally use a specially designed heating "blanket" which is similar in size to the fingerboard's extension. This allows me to heat only this part of the fingerboard without heating the surrounding finish.

Before the days of handy sized heating blankets I used a traditional clothes iron. This required shielding the instrument's top from the heat to avoid blistering lacquer and other vulnerable finishes.

With the glue soft from heating I use a smooth spatula to slide between the fingerboard and top. Using a smooth, even polished spatula insures the finish around the fingerboard is not scratched. When the finish is fragile I use low tack, paper tape to protect it. (Think Post-It® sticky) On vintage instruments with flakey finishes it can really come in handy.

Step 2: Steaming The Neck Loose

With the fingerboard still hot I remove the fret which lies directly above the dovetail pocket. On nearly all instruments this is one fret up from where the neck meets the body, this is usually the 15th fret.

With this fret removed I can now drill a hole straight thru the fret slot which will lead directly into the pocket. This serves to avoid any visible signs or changes to the fingerboard that would indicate a repair had been done.

Drilling a hole thru the fret slot helps to avoid any obvious change to the instrument.

Steam is injected into the neck block to soften the glue. Instruments with loose necks may permit steam to escape around the heel of the neck. When this is an issue I use an air hose to blow steam away from the area, keeping it dry and cool.
Some truss rod nuts are accessible beneath the fingerboard extension, as a result steam will also find it's way out thru the truss rod hole and care must be taken to plug the hole and protect the interior of the instrument.

Steaming usually takes only a few moments. In all but a few instruments water soluble glue is used. Because a well fit dovetail is relatively tight, very little glue is between the dovetail and sides of the neck block.

Step 3: Removing The Neck

Pushing the neck free from the body.

As the glue is softened the neck begins to move with effort.As separation becomes apparent I apply pressure to the heel cap to press the neck out of the block. When the fit is very tight I use what I call my "sissy jig". It's a real life saver when my bionic thumb can't do the job.

Step 4:Changing The Necks Angle

Once the neck and joint have dried and old glue is removed the neck's angle is changed by shaving material from the heel.
I use chisels to remove the majority of wood, followed by sanding sticks when necessary.

A new taper of the heel's sides will increase the neck angle.

When string height has risen due to an increase in the top's arch (belly) material is removed from the bottom portion of the heel, tapering gently to the top of the heel (below the fingerboard). With the instrument lying on it's back this adjustment would pitch the neck back, placing the peghead closer to the bench.

Wood is removed in very small increments, the neck placed back in the pocket to recheck it's angle, rinse and repeat...

As detailed in my article on neck angle we are adjusting the necks angle to insure it's plane passes over the bridge.

While shaving wood from each side of the heel, the side to side pitch of the neck is also closely watched. Removing more wood from one side than the other would place the outer E strings unequally from the edge of the fingerboard.

Ideally the center of the fingerboard should run right between the D and G bridge pin holes. When dealing with vintage instruments it is not uncommon to find that the bridge is not dead center on the top, so to avoid an issue the neck is centered using the bridge, not the top's center glue seam.

Step 5: Shimming The Neck Block

After adjusting the neck's side to side angle and it's pitch, shims are used to lock the dovetail in place.

I glue mahogany shims to the sides of the neck block and start the process of fitting the actual dovetail, that which "locks" the neck in place. The shims are sanded to insure an even fit from top to bottom of the heel.

A well fit dovetail will hold a neck in place before glue is even applied.
At this point all angles are re-checked to insure nothing has been overlooked.

Step 6: Re-gluing The Neck

The easiest part of the job ...gluing the neck back in place. Titebond Regular is applied to the sides of the dovetail joint and beneath the fingerboard extension.
Clamps are used above the dovetail and over the fingerboard to insure complete seating of the joint.

Gluing the neck back on a Martin guitar.

The Grand Finale

Titebond (and other aliphatic glues) are water soluble. This permitted the neck to be removed with steam. It also makes clean up relatively easy as well. Warm water will clean up dried glue that has squeezed out during clamping.
Now that the angle of the neck has changed the fingerboard is now bending slightly downward to make contact with the top. For a truly professional job the fingerboard is planed straight and re-fretted. The tiny holes drilled beneath the 15th fret filled and now a distant memory.
Due to the changes in the neck's angle, the instrument's saddle andnut may need to be replaced during the set up.

Cost

Neck resets are not often performed on inexpensive instruments for the simple reason that they can actually be replaced cheaper than they cost to repair.
Neck resetting a dovetail joint like the one detailed above start at**$650**.

Nut Replacement

Guitar nut

The nut is placed at the end of the fingerboard and controls the strings spacing, distance from the edge of the fingerboard and their height above the first frets. Nuts can be made from a variety of materials and require adjustment or replacement when wear and tear creates problems.

Common Problems:

- Open string buzz
- Slots too big for the strings diameter
- Outer E strings sit too close to edge
- String binding, pinging
- High action at first fret
- Poor intonation

Tapping nut loose

Removing The Nut

Some guitar nuts are very easy to remove. Using a block of wood to distribute the impact, a small tap of the hammer will pop them loose if they sit with only one side against wood (the fingerboard).
However, it is a different story when the nut sits in a channel. These have support from the peghead and fingerboard. Trying to tap these forward could damage the peghead veneer and nut.

Avoiding Finish Chips

Many manufacturers install the nut on the neck prior to paint work. When that finish is thick it is easily chipped when removing the nut. The best chance to avoid chipping is to score the paint around the sides of the nut and across the peghead with a fresh x-acto blade.

Inlaid (Boxed In) Nuts

Nuts that sit in a channel (inlaid nuts) can be removed in a number of ways, all depending on what technique best suits the situation.
Tapping the nut sideways often loosens to the point that it can be removed by hand.

Pushing nut out sideways

Griping the nut with blunt end nippers is another option but the risk remains that the nut may crack or be damaged by the attempt.
Some nuts have been glued in a very tight channel using un-necessarily strong adhesives, this makes them very difficult if not impossible to remove in one piece. When this is the case it is sometimes necessary to cut a relief kerf in front of the nut (.008 slot) so that it may be tapped forward and loosened. The minor relief slot is difficult to detect and filled by the new nut.
Under some of the most difficult circumstances, the nut must be sawn in half and literally collapsed in order to remove. This is done to avoid damaging the nut slot or peghead.

Installing A New Nut

Pre-slotted and shaped

Ready made nuts are available for installation on many instruments, however, adjustments to the slots must still be made. Slots must be filed to insure their width and depth create correct string height.

Using nut files to cut string slot width and depth

This is done using gauged Nut Files which are made specifically for cutting nut slots. The use of inappropriate tools can quickly ruin the nut and cause buzzing.

Made From Scratch

Nuts are often made from scratch when a different material is desired or a ready made nut of appropriate size is not available.
Most material is available in blanks and are shaped accordingly.
I like to tackle it in this order:

- Sand blank to correct width for slot
- Sand base to sit properly in slot (some are angled)
- Sand basic height

- Mark E to E string spacing
- Shape sides of nut to proper width
- Cut preliminary string slots
- Sand final shape
- Polish material
- Install and cut final string depth

Ivory nut being shaped

The most difficult stage in making guitar nuts from scratch is probably spacing the strings properly. The initial cuts are extremely important. I would recommend starting with a razor saw (small kerf) to make the initial slot and then increase the width in steps to keep slot perfectly centered.

Adjusting String Height

It is important to have the instruments saddle height and truss rod set properly prior to cutting the string depth in the nut. Cutting a slot too deeply will place the string against the first fret and result in buzzing.

A good indication that the nut slots are cut/worn too low is strings that buzz only when played open (un-fretted).

Slot Depth

The depth of the slots in the nut determine how closely the string comes to the frets, particularly the first fret. It is critical that the string have ample room to vibrate without contacting the first fret or you'll have an annoying open string buzz.

Adversely, nut slots that have not been cut properly can leave the strings higher than necessary above the first fret. This creates discomfort and higher action. A minor adjustment (say .020) can make a very noticeable difference.

High action at the nut also sharpens intonation.

Slot Width

Each string slot should just slightly exceed the diameter of it's string. If the slot is smaller than the string it may bind and create tuning problems. (And that annoying pinging sound when tuning up.) If you've ever had to lift a string from a nut slot when changing strings it's a sure sign the slot is too small.

When changing string gauges, an increase in string diameter sometimes require an adjustment to the slots width.

Slot Angle

The slots must also be angled correctly. If the angle is too steep the string may actually rest on just a small portion of the slot causing premature wear as it is sitting on a small peak.

On instruments with minimal peghead angle the angle is especially critical for a clear, clean sound. A poorly angled nut slot can create a buzz like sound that can often be silenced if downward pressure is applied to the string behind the nut (over the peghead). This is often a sign that the string is not contacting the nut slot properly. The sound very closely mimics the sound of the string hitting the first fret when the slot is too deep.

Nut Height/Final Shape

Once the slots have been deepened I may remove material from the top of the nut, if need be, to avoid having the strings deeply buried in the nut. I want the slots deep enough to keep the strings from popping out when plucked but not so deep that they're buried.

Raising Action at the Nut

There are good reason's to salvage an original nut if possible. First of all vintage instruments often have lovely ivory and ebony nuts that are just too nice to scrap.
And of course, it is cheaper, especially if you have an instrument for which no pre-made plastic nut is available. Making a bone nut for a $100 guitar would not make much sense.
My method of raising the nut is to laminate matching material to the bottom of the nut. I use the term **laminate** and not **shim** because it is glued to the nut and can only be removed by sanding.

> **How about filling low slots and re-cutting?**Superglue and baking powder have been used to fill nut slots that have been cut too low. I do not like the tone I hear from this method and prefer to raise the nut as a whole and re-cut.

Shims are placed beneath the nut and are often destroyed if the nut is ever removed again. I have seen the made from wood veneer, paper even pieces of credit cards. In my opinion, they look awful. When laminating material to the base of the nut it becomes permanent and more difficult to see. The nut can then be removed just as any other without having to make a new shim.

Securing a Loose Guitar Nut

If a nut pops loose I recommend using a couple of drops Elmer's or wood glue to reattach it. The use of permanent adhesives can create problems should the nut need to be removed for future repairs.
A small dab between the end of the fingerboard and the nut will do the trick and permit easy removal that does not damage the bottom of the slot when removing.

Lubricating Nut Slots

On occasion it is helpful to lubricate the nut slot to reduce friction, binding and pinging. Because acoustic guitar usually have light colored nuts, using white graphite is often preferred to pencil lead graphite.

Replacing Pickguards (Scratch Plates)

Depending on the instrument, some pickguards may be a cinch to remove while others stick quite well and require care to avoid damage. The first thing you want to know is what finish is on the instrument and whether the pickguard adheres to finish or directly to bare wood.
Most pickguards require heating to soften the adhesive prior to removal, a task that warrants caution as overheating lacquer and delicate finishes can cause them to blister and create an enormous problem. I prefer a hairdryer to soften the adhesive.

Removing the adhesive left by a self stick pickguard.

Finishes, like Taylor's U. V. cured finish and other polyester finishes withstand heat far better than lacquer and shellac.

I've used a number of items to help aid the removal from a plastic putty blade to dental floss and thin fishing line. Sticky residue left behind can usually be removed with Naphtha, which would be safe on a variety of finishes though a bit slow for the more durable surfaces.

Martin's Shrinking Pickguards

Pickguards glued directly to the bare wood can cause top damage when they shrink.View a Martin pickguard replacement.

Once the pickguard is removed you will usually find a tan line, a change in color caused by the woods U. V. exposure. While this tan line is a helpful guide

Tan Line

Top did not darken beneath pickguard

to correctly position the replacement, it also means that you are forced to replace the original guard with one similar or larger unless you want to see the shading.

Pickguard Types

Clear Pickguards

For those who don't prefer pickguards but are afraid of damaging the finish you may opt to install a clear pickguard. Clear pickguard material is much thinner than regular celluloid pickguard material and applies much like a sticker. While this can sound ridiculously easy, more experience is needed to apply these correctly than a traditional guard.
The clear pickguard acts like a sticker and bubbles are sure to find their way between the material and the top if not applied correctly.
I install these by floating them on a bed of water and using a squeegee to force out any bubbles before adhesion. Starting from the tip and working slowly towards the bottom, being careful to never touch the adhesive.
Though these are easy to cut with scissors, the crisp factory edge that's required for a professional looking pickguard requires cutting with a template or purchasing one directly from the factory or supplier.
Clear, removable pickguards are similar to the vinyl stickers that cling to glass.

Pre-made Pickguards

Vintage pattern pickguard

Most of what you'll find in the $5-$10 range today are basic, stamp cut pickguards.
Luckily there are several tort and multi-colored pickguards available that give those of us who dislike the plain pepperoni that seems to be so common.
Greven® pickguards by Turtleworks® happen to be my favorite replacement on vintage Martin's and those looking for unique patterns. The color on these go throughout the material as opposed to some pickguards being made today with a faux tort pattern covered by a clear top laminate.

Hand-Made Pickguards

When the appropriate shape and size are not available or when creativity strikes pickguards can also be made from scratch.

Plastic is scored heavily and snapped free

Using the original as a template, I scribe around the edges with an awl until a deep channel is made. The material can then be snapped free and the edges dressed, beveled and buffed. Online retailers who specialize in pre-made pickguards have a catalog of templates and can make replacement guards even when the original is not available.

Thick Pickguards


Thick Celluloid Pickguard

Thicker pickguards can also pose a problem, a common issue is celluloid decay which causes them to crumble. It begins with a crazed, shattered like appearance which advances to the point of disintegration. These too must be replaced but unfortunately an exact material match is not usually available and we must use what's available.

ArchTop and Floating Pickguards

These are also made from thicker material, usually around .100-.125 thick as opposed to the thinner material used on many flat top guitars. They attach to the top by brackets and screws. These are obviously quite easy to remove and replace yourself. Finding replacements for these pickguards has gotten much easier as shops have manufactured templates by which they can re-make the guard using your material choice. When they do not stock a template for your instrument many will offer to make one using a tracing of the original.

Inlaid Pickguards

Want something truly personal? Most inlay artist can give your instrument a truly personal touch by inlaying a pattern of your choice into a pickguard.

Acoustic Guitar Pickup Choices

Types

Undersaddle Pickups

Piezo pickups that are installed under the saddle have a small wire passing thru the bridge and top thru a tiny hole drilled beneath the saddle. The input jack is mounted in the end bock, taking the place of the original end pin.

Fishman Matrix

LR Baggs Element
PROS Feedback resistant
CONS Loss of direct coupling between saddle and bridge

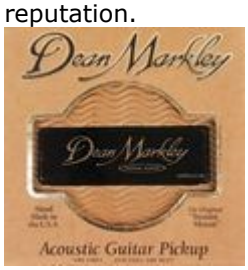
Contact Pickups

Contact pickups are usually mounted on the bridge plate though there are some that mount to the bridge or top. They sense the vibration of the soundboard and as such are adept at picking up any tapping on the body.
Because contact pickups do not rely on the saddles height or the strings pressure they often excel in providing a well balanced, even string balance and are ideal for instruments with non-standard saddle slots.

LR Baggs iBeam
PROS Balanced string to string output
CONS Will pick up taps on top and finger noise

Soundhole Pickups

These are easy to install pickups that mount in the soundhole. They can be used on instruments which one would prefer not to alter or to uninstall easily.
Quite honestly, these use to sound simply awful, nothing more than a single coil electric guitar pickup on an acoustic guitar. Today however advances in technology have changed their bad reputation.



Dean Markley Pro Mag

Fishman Rare Earth
PROS Avoid any modifications to guitar
CONS Very visible, different tone

Dual Source Pickups

Dual source pickups are exactly what the name implies. Instruments with dual source systems achieve their sound by blending 2 different pickups. These types of pickups often give the player more options when shaping their sound and perhaps more importantly to some...the ability to use the microphone only when feedback is not an issue.

Fishman Rare Earth Blend

LR Baggs Dual Source

LR Baggs Anthem
PROS Blending of input source yields greater tonal range
CONS Expensive, bulky

Internal Microphones

Microphones are often hailed for their accurate reproduction of sound. Due to a microphones natural tendency to feedback when used in a loud setting many opt to use them in a dual source set up, giving the user the ability to blend 2 pickup sources and handle a larger variety of demands.

LR Baggs Anthem Microphone
PROS Tone reproduction
CONS Feedbacks easier than other pickups

Acoustic Guitar Saddles

The saddle sits directly in front of the bridge pins on an acoustic guitar.
The position of the saddle affects:

- Intonation (the guitar's ability to play in tune)
- Action (string height above frets)
- Tone (different materials change tonal properties)

Most acoustic guitar saddles are either 3/32" or 1/8" wide.

Types of Saddles

Drop In Saddles

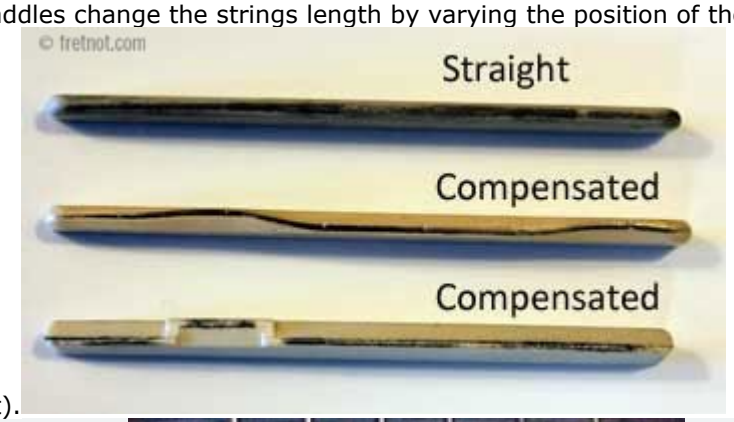
A drop in saddle sits in a routed slot in the bridge. These are fairly easy to remove and should not be glued in place.
Lowering drop in saddles is done by removing material from the bottom, unless the saddle's crown or radius also needs work.

Long (Set) Saddles

Set saddles extend into the wings of the bridge and are usually glued in place to prevent movement. The ends of these saddles are further shaped after being glued in place to give the bridge and saddle a uniform shape.
To remove a long saddle that has been glued in place the saddle itself must be heated to soften the glue. The top and finish must be protected from heat to avoid damaging the finish, particularly lacquer, as it is easily damaged by heat.
I use a protective shield that leaves nothing but the saddle exposed before heating it with a hair dryer.

Compensated Saddle

Compensated saddles change the strings length by varying the position of the saddle's crown (point of contact).



Compensated Saddle

Compensated saddles are used to improveintonation which effects the instruments ability to play in tune up and down the neck.

Adjustable Saddles

Adjustable saddles are raised and lowered via screws making height adjustments very easy. The downside, they provide very poor coupling between the strings and bridge and don't always result in the best tone. As these saddles are raised a greater gap between bridge and saddle is created.

Adjustable saddles use screws to change string height

It is not uncommon to have this style of saddle replaced by upgrading the instrument's bridge which removes this hardware and uses a traditional drop in saddle. Conversion bridges are made to match the original's outline but equipped with a traditional drop in saddle.

Adjusting Saddle Height

When we use the word "action" we are referring to the distance between the strings and the top of the frets. As any player knows, having an instrument set up properly makes them sound and play better. The saddle's height directly effects the instrument's overall action and string height.
Prior to lowering a saddle, neck relief should be correct.

Lowering A Drop In Saddle

When lowering drop in saddles, the saddle is removed from the bridge, marked for reference and material is usually removed from the bottom to avoid having to reshape the crown. This is particularly helpful if the saddle's crown is compensated.

Lowering A Set Saddle

A bit more patience is required to reduce the action height on guitars with set saddles. These saddles are normally glued in place and material is removed from the top (crown) to reduce their height. If material was removed from the bottom the saddles length would be shortened and an obvious gap would appear between it and the bridges saddle slot.
After the appropriate amount of material is removed the saddle must be re-shaped to produce the rounded crown.

> **Why do saddles require lowering?** As age and string tension pulls on the top of a guitar, it's arch (belly) increases and raises the action. The saddle is lowered to counteract those changes.

Changing The Radius

The radius is the arched (E to E) shape of the saddles crown. **In general, most manufacturers match the saddle's radius to that used on the fingerboard.**
Having a saddle that is over radiused may place the D and G strings un-necessarily high.

Raising The Saddle

When saddles are too low it is best to replace them. Adding shims beneath a drop in saddle can have a negative impact on tone.

Saddles With Integrated Pickups

Ovation and other manufacturers use specially formed saddles that fit into their pickups. These saddles should not be sanded or altered. Instead, shims are added or removed from the bridge saddle slot beneath the pickup to adjust string height.

Why Are Saddles Different Heights?

Because the top of a flat top guitar takes on a greater arch (belly) with time, the saddle gives us the ability to lower the action when this arching raises string height further above the frets. The angle at which the neck is set will also influence the height of the saddle. Instruments that need a neck reset often have very little saddle protruding above the bridge.

Very Low Saddles

The saddle on many flat top guitars will eventually meet their limits. Having been lowered repeatedly thru the years, they are now too low for further adjustment.
On a valuable or high quality instrument a neck reset is the corrective action. Resetting the neck angle will permit the saddle height to return to normal and lower the action.

> Having a very low saddle reduces the downward pressure on the saddle and can negatively effect the output of under saddle pickups.

When the instrument does not warrant the expensive of a neck reset, bridge thinning may also be an option. Again, this is not recommended on valuable instruments as it simply adds to the repairs needed....
neck reset + new bridge = even more money!
Thinning a bridge is an option only if the bridge itself is thick enough to allow for a reduction in height. We must take into consideration the depth of the saddle slot as well. A shallow saddle slot does not provide the support necessary to keep a saddle in position.

Tweaks

Bridge pin hole ramping

If a saddle is too low, the strings will pass across the saddle and into the bridge pin holes without enough angle to produce good tone. The result is a sound that very much resembles a sitar to me. In order to increase the string's angle into the bridge pin hole a ramp can be filed at the front of the bridge pin hole. I refer to this as "ramping". The additional string angle which it creates can help to clean up the "sitar" sound and place more pressure on the saddle.

Installing Strap Buttons

Installing a strap button on a guitar or other instrument is by no means rocket science but it pays to be cautious and mindful of what you're doing. This article will detail the way I do it, the tools I use and tips for proper installation. If I showed you some pictures of do-it-yourselfers gone wrong you would quickly understand how such a little job can create such big problems.

What's Needed:

- A strap button with mounting screw and felt washer
- An awl for marking the correct position
- A tapered drill bit that matches the mounting screw
- Wax for lubricating the screw
- A countersink to prevent finish chip

I take a few steps that some may consider needless but do so to insure a perfect outcome every time. While my technique may be overkill for some, others will appreciate my attention to detail and assumption that caution is never a waste of time. There's something about drilling a tiny hole in a $10K guitar that can make even an avid woodworker squirm.

Choose The Position

If you don't get this right it's all downhill from here. When choosing the spot to mount a button it must pass a few simple test....

- **Will the hole I'm about to drill contact a neck bolt?** There are more and more manufactures using bolts in their construction and you need to know where they're located before drilling a hole. Most of the time a cover plate or label will be used on the end of the neck block to conceal the bolts. You need to find out first where the bolts are located.
- **Will the button interfere with my fretting hand?** You definitely don't want the button mounted so close to the fingerboard that you and it will make constant contact when playing up the neck.
- **Does the position of the button hold my strap securely?**Buttons should be pointed towards the floor, not the ceiling. Placing a button on the wrong side of the neck is a common problem for do-it-yourselfers.

Mark The Spot

Once you are sure about its position you can mark the spot with an awl. This indentation keeps the drill bit from walking when it's time to drill the hole .Typically (that does not mean always) the button will be at a distance half way between the heel and bottom of the fingerboard.

Many manufacturers use mounting bolts that pass thru the neck block and into the heel. It is critical that you are aware of the position of that bolt if present.

Bevel The Finish

This will not apply to all finishes but is quite important when dealing with instruments who's finish tends to chip easily. When a drill bit or wood screw first enters the hole it lifts the wood slightly and this can cause some finishes to chip.
This is done with a very light touch and is meant to merely bevel the finish, **not create a countersink in the wood**. I may repeat this more than once if the finish warrants it. With truly problematic finishes I may even run lacquer thinner around the hole to melt down any finish that wants to lift.

Drill The Hole

Tapered drill bit with tape to mark depth

As I mentioned previously, I use a tapered drill bitthat matches the strap button screw. This ensures that the screw has gripping power thru its entire length.
This is a pretty important screw and we want to make sure it's going to hold for years...oops, forever!

A Touch Of Wax

When installing screws for the first time I often choose to place a bit of hard beeswax on the screw to cut back on friction. Once a screw is lubricated very lightly with wax it should go in firmly but not so forcefully you risk cracking the neck. That is an even greater concern when drilling into the heel cap!

Common Problems

- Drilling into a neck bolt which makes it necessary to plug the hole and drill another. That could ruin your whole day!

- Placing the button on the wrong side of the neck. The button should be pointing to the floor not the ceiling.
- Drilling too small of a hole and splitting the heel when installing the screw. Feel the pain!
- Drilling too large of a hole. Or... watching your peghead break off when the neck plummets to the floor after the strap button popped out.
- Taking a large chip of finish off with the drill bit.

I have a flare for the dramatic huh? When you have seen all of these scenarios, as I have, then you realize that people have and can make all of these mistakes.

Wide Flat Heels

Wide heel with strap button

Here's a button that's been installed in the heel cap.
While this is a popular spot on instruments with wide heels and cut-a-way sides, it isn't the best scenario.
Some "athletic" players have a tendency to push the guitar away from their body, which pulls at the strap button. If you are impersonating Elvis I would stick with a traditional placement.

Loose Strap Buttons

If a strap button is **very** loose, so much so that the screw spins freely and the button can be pulled out by hand, it is best to repair the hole by plugging it and re-drilling. I use a small dowel, or a toothpick, if it is large enough.

> **Should I glue the button in the hole?** That would be a rather emphatic no!
> Glued in screws are often broken when someone attempts to re-tighten them.

Titebond is best for gluing dowels as Superglue would ooze out of the hole, causing damage to the finish. Once the glue dries I level the dowel with the finish and drill it for a new strap button screw. Keeping the dowel to the smallest size necessary means it will be invisible when the strap button is installed.

Only A Little Loose

When a screw still has gripping power but still will not snug up, we can sometimes reinforce the hole instead of plugging it.
I have to say this again...**do not glue the screw in the hole**!
I take medium viscosity superglue and coat the walls of the screw hole in order to build them up slightly, thereby decreasing the actual size of the hole and hardening the walls. More than one coat may be necessary, however, before installing the screw **the glue must be dry!**

Changing Guitar Strings

Restringing Your Guitar

One reason we find ourselves constantly re-tuning a guitar is **string slippage**. Strings need to be anchored securely at the bridge and at the tuning machines to insure they do not slip. When strings slip they loose tension and the guitar goes out of tune.
This is one method of winding the strings around the tuning machines to eliminate string slippage.

Winding Strings Around the Tuning Machines

Step by step guide to restringing your acoustic guitar.

Step 1:

Bring the string down the center of the peghead and thread it out towards the tuner's knob.

Step 2:

Leaving a bit of string length to wind around the tuner, bend the string gently towards the top of the peghead.

Step 3:

Pass the string up and under itself.

Step 4:

Keeping tension on both ends of the string, fold the string over itself.

Step 5:

Continue to hold tension on the string and begin to wind.
The string should be wound down the shaft to increase the strings angle over the nut.

The End Result

The strings own winding "clamps" down on it to prevent string slippage.

More Restringing Videos

Stringing Slotted Pegheads

Instruments with slotted pegheads benefit from a different method to reduce binding of the string in the nut slot.

What Guitar Strings Should I Use?

Basic Choices

Choosing the right strings for your guitar is more than picking your favorite brand. The size and material the string is made from can effect your guitar's action (string height) and tone.

String Gauge (Size)

Strings come in different sizes. When speaking of acoustic guitar strings we often denote the size by stating; light gauge, extra light gauge, medium gauge, etc.
Larger gauge strings can help boost volume and sustain but can be more painful on tender fingertips unaccustomed to the tension or those bending strings.
Lighter gauges are often easier to fret and bend, but very light strings can cause some players to over-bend the string causing the note to play sharp.

Material

A strings material also affects tone. Common materials are Nickel, Bronze, Phosphor Bronze, Stainless and Silk and Steel.

Brand

Though most of us have our favorite brands, another way to experience different tone is to try various materials.

How String Tension Effects Your Guitar

Here's how using smaller or heavier gauge strings effects your guitar...

Action (String Height)

First and most importantly is our set up. Instruments that have been set up properly to insure appropriate string height, nut slot width/depth, intonation and neck relief have been done using the string gauge the player is using. If one changes string gauges, more or less tension is being placed

on the instrument depending on whether they go up or down in string gauge. This can affect everything about your set up and require several adjustments.
If you are experimenting with tone, try various materials and brands but remember to choose the same gauge to avoid changing the action.

Sound / Volume

Besides affecting the action, a change in tension may also affect the sound (sustain and tone). Some players may choose to increase the string gauge on their instrument in hopes of increasing volume and sustain.

> A common complaint when using very light or extra light gauge strings is a loss of volume, sustain and a thin or twangy sound.

Comfort

Alright, not that you could have missed it but ...bigger gauge=more tension, and more tension=more pressure on your fingertips while fretting. This tension is painful at first but callus and frequent playing reduce or eliminate it with time.

Let's not forget string benders. Not all of us can take an .011 gauge E string and bend it 2 notes sharp. Any players choose their string gauge according to their playing demands.

> Extra light gauge strings which offer little resistance to the players touch can easily be over bent when fretting or string bending.

Special Considerations

Not all instruments can handle medium gauge strings just as not all instruments fair well with extra light strings on them. Here are some things to consider...

Age / Construction

While most new instruments are solid enough to give the player the option to choose from several string gauges, vintage pieces or those with structural problems may limit your options.
Older instruments that were originally designed to be strung with gut strings or were braced lightly, require very light gauges and should be structurally sound before submitting them to tension.
If you are thinking about stringing up a vintage instrument for the first time I highly recommend having it inspected. All braces should be securely glued to the top and back. The bridge and bridge plate should be inspected and all other areas of stress should be checked for cracks or looseness.

Neck Relief

Another common problem that robs us of our string choice is the necks condition. Let me give you an example:
A 1967 Fender Strat comes in with a neck that is slightly back bowed (fingerboard is higher in the middle than the ends). After inspecting the truss rod I learn that it is completely loose, leaving us without the ability to introduce proper neck relief by loosening the truss rod. We opt for a heavier gauge string that puts more tension on the neck, pulling it straight.
Likewise a neck with entirely too much relief may require a lighter gauge string in reduce the tension with hopes of decreasing relief.
More information on common neck issues and truss rod problems.

Adjusting Guitar Truss Rods

Truss rod adjustments are made to **alter the straightness (flatness) of the neck.** Truss rods often require adjusting after changing string gauges or when temperature and humidity change the amount of bow in the neck. Read how to check neck relief, find the truss rod nut,determine the correct measurement and avoid common problems.

Checking Neck Relief

Relief is calculated with the instrument **tuned to pitch** so we can measure the bow created by string tension.

Checking Relief With a Straightedge

With a straightedge placed between the D and G strings, bow will become apparent. The largest gap is usually towards the center of the neck.
The distance between the top of lets say the 7th fret and the bottom of our straightedge can be measured with a feeler gauge to give us an exact measurement.

Checking Relief Using The Strings

Fret the string on the 1st and last fret of the neck.
Measure the gap between the string and top of 7th fret. (14 fret neck)

More commonly we use the string itself as a straightedge.
Fret the string at the 1st and last fret. Measure the gap between the bottom of the string and the top of the 7th fret.
A capo can be used on the first fret to free up one hand.
A **large gap** will indicate the neck has too much relief and the rod may require tightening to straighten the neck.
No gap may indicate the neck is dead flat of backbowed which may require loosening the truss rod to add relief.

> **What does it mean if there is no gap?** If no gap is seen between the bottom of the string and the top of the fret then either the neck is dead flat or it is back bowed.

When To Adjust The Truss Rod

Common problems associated with, but not exclusive to, neck relief are:

- Buzzing
- High action
- Poor intonation

Ideally we are adjusting the truss rod to render the neck as flat as possible without creating too much string buzz.
It is important to understand that **there is no single measurement**that will be correct for all acoustic guitars. String gauge, playing style, neck and top stiffness can vary from one guitar to the next and as a result, so can ideal neck relief.

Measurements
.004"- .006" is probably best for light pickers, jazz musicians and instruments strung with medium gauge strings.
.008"- .012" is probably best for hard strummers, guitar's strung with extra light gauge strings and fingerboards with a tighter fingerboard radius.

How I Adjust Truss Rods

The measurements above serve as simple guidelines and starting points to those still learning about neck relief. How else would we understand what "just a little" or "way too much" actually equals?
When making truss rod adjustments I first assess the instrument's action and playability along with the players aggressiveness and playing style. That is why truss rod adjustments are normally done in conjunction with a set up.
Starting with a dead flat neck I increase neck relief slightly until the instrument plays without buzzing. That being said ...you must have an understanding of what other issues can cause an instrument to buzzwhen using this as your gauge.

Locating The Adjustment Nut

Adjusting a russ rod nut located at the peghead

At The Peghead

Truss rod nuts are located at either the peghead or the end of the neck.
Nuts located at the peghead are often concealed behind a small truss rod cover and are easily accessible.
These will require either an allen head wrench or a socket style truss rod wrench.

At The Heel

Truss rod nuts located at the heel end of the neck are often accessible thru a hole just beneath fingerboard extension and thru the top brace.

A heel end truss rod nut accessible thru a hole in the top brace.

In general these will require an allen head wrench which will pass thru the hole and straight into the nut. The depth at which this nut is located can vary which means some instruments will require a longer wrench than others.
Using an **L shaped allen wrench** on these truss rod nuts provides greater leverage.

The Hidden Nut

A few instruments have truss rod nuts at the heel that are not readily visible. A mirror must be placed inside to see the access point. These often require **specially shaped wrenches** which will snake around the top brace and back up to the heel of the neck.
Notice the curved wrench to the left below ...this passes under the top brace and back up to the truss rod nut.

An assortment of truss rod wrenches

Which Way Do I Turn?

Tightening A Truss Rod (Righty Tighty)

If a neck has too much relief (upward bow) tightening the truss rod will straighten the neck.
How? The truss rod is actually compressing the neck exerting pressure against the backside of the neck which causes it to bend backwards.

Loosening A Truss Rod

If a neck is too flat or backbowing, loosening the truss will add relief.
How? Relief is actually created by string tension, once a truss rod has been completely loosened the strings not pull relief into the neck with less resistance.
Changing string gauges may require a truss rod adjustment as this changes the tension on the neck..
Finding a balance between the tension exerted by the strings and by the truss rod is how we control the amount of relief. This is why the instrument should be **tuned to pitch** before adjusting the truss rod in most cases.

How Far Do I Turn The Truss Rod Nut?

Start by making small adjustments, say **1/8th of a turn**. On some instruments this may result in a noticeable change in relief, in others it may not. The amount the rod must be turned will vary according to the type/quality of truss rod and amount of adjustment necessary. Adjusting the truss rod with the instrument tuned to pitch will allow us to gauge our progress and continue re-checking relief before making further adjustments.

Precautions

The number one reason people won't touch the truss rod is that they are afraid of making a mistake and damaging it. It's a healthy fear actually but once you understand how it functions and get some practice you should be able to make these adjustments yourself.
Some important things to remember:

- Use the appropriate sized wrench/socket (if in doubt check the manufacturer's website)
- Start by loosening the rod a little first*
- Stop if you encounter resistance**
- **Stop if the adjustments you've made do not change anything**

Numerous instruments have come to me with striped truss rod nuts, this is avoidable in most situations. Using the wrong sized wrench/socket may permit it to round out the threads and ruin the nut.
Not all truss rod nuts are replaceable, some are welded to the rod. Be sure to use the correct wrench!

Common Truss Rod Nut Sizes
Martin & similar acoustics **5mm allen head**
Gibson & similar acorn style nuts **5/16" socket**
Taylor & similar small nuts **1/4" socket**

*If a truss rod is already as tight as it can go, starting an adjustment by tightening the nut first could end in a horrifying pop. If one starts by loosening the nut slightly they can quickly get a feel for how much tension is already on the rod.
**Starch resistance and creaking sounds can be a sign that the truss rod should not be adjusted further and is more than enough reason to stop and seek help.

Installing Tuning Machines

Shrunken celluloid
tuning machine button

Tuning machine replacement s necessary when desiring a better quality tuner or to replace a damaged one. With the exception of some bass tuners they are normally sold as sets, not individual tuners,
Worn out tuners often have excessive play between the round and worm gear resulting in skipping or play in the tuning machine arm (movement with response from the tuning machine post).
Generally speaking, if you can find retrofitting replacements for your instrument this is normally a simple procedure. When the machine head bushing has a nut and washer then it must be removed before the tuners will come out, other simply have press fit bushings when do not need to be replaced if the same design is being used.

Selecting New Tuners

When choosing a replacement tuner that is not identical to that which you are replacing it is important to note measurements of:

- Post height
- Post hole size
- Mounting screw pattern
- And sometimes, tuning arm length

Tuning post height can vary. It is important to insure the string hole will still be accessible once the tuner and it's bushing are installed on the peghead. Be sure to check the specifications before drilling any new holes.

Fitting New Tuners

If you are replacing your old tuners with identical tuners then you need little more than a screwdriver and nut driver, however, if the original style is not available or not desired some upgrades may require modifications.

Such modifications may include:

- Enlargement of peghead holes for larger shafts or ferrules
- Filling old mounting screw holes
- And though rare, filling and re-cutting of peghead holes to accommodate for different spacing for tuners mounted on a plate

Care should be taken to avoid chipping the finish or peghead veneer when removing pressed in machine head ferrules. When dealing with vintage instruments it is highly advisable to seek a retrofitting replacement so that no changes are made if possible.

Gear Ratios 15:1 18:1 20:1

The gear ratio indicates how many times the tuner button is rotated 360° to one turn of the tuners post. A higher ratio permits finer adjustments, reducing the aggravation of tuning up and down repeatedly before perfect tuning is achieved.

Removing Tuning Machine Bushings

Tuning machine bushings, also called ferrules, are inserted into the front side of the peghead and act as a collar for the post. Some bushings screw to the tuner, others are pressed into the peghead and held in place by friction.
When removing a press fit bushing care must be taken to avoid chipping the peghead or finish. Some of these bushings are extremely tight. Others have been glued in place in an attempt to keep them from falling out...not recommended procedure.
The safest method I have found to remove them is to press them out. Using a simple wood block which I have drilled to match the diameter of the bushing, it is placed over the ferrule and a dowel is used to press it up and out. Sometimes you can do it by hand, on very tight bushings, I must use a clamp.

> **My instrument won't stay in tune, are the tuners at fault?** In general, worn out tuners make an instrument hard to tune. Loss of tuning has many causes. Read more here.

Loose Bushings

The ferrules (bushings) that press into the fingerboard don't always fit snuggly. If one isn't careful it is quite easy to loose these when the strings are removed.
To tighten bushings that are only slightly loose without permanently gluing them into the peghead hole I shrink the diameter of the hole.
If the gap is minor and does not warrant filling and re-drilling then I use superglue to build up the walls of the hole until it becomes smaller in diameter. **Again, we do not want to glue the ferrule to the peghead as damage can result when it must be removed.** The superglue is applied and completely dry befo

Guitar Tuning Problems

Guitar Will Not Stay In Tune

One common tuning complaint is having to repeatedly tune an instrument. It can be tuned and it will play in tune up and down the neck but it requires frequent re-tuning.
If any instrument will not stay in tune it all boils down to couple of possible factors:

String Stretch

- New strings require stretching and take time to settle in
- Note bending stretches strings

String Slippage

When string tension is lost thru string slippage, re-tuning is required. Slippage can occur for reasons such as:

- Ball end needs to seat against bridge plate
- String binding in the nut or saddle slot
- Strings poorly wound around tuning post
- Poorly tied to tie block (classical guitars)
- Badly worn tuning machines

When re-tuning is frequently necessary, most of the time, the string is slipping at the tuning machine.

How can I keep my strings from slipping around the tuning post? This winding technique is one way to tie strings to the tuning machine to eliminate slippage.

What If My Guitar Will Not Play In Tune?

After tuning your instrument you find that certain fretted notes sound out of tune or chords do not sound in tune with themselves.
Intonation correction is often necessary to remedy this issue.

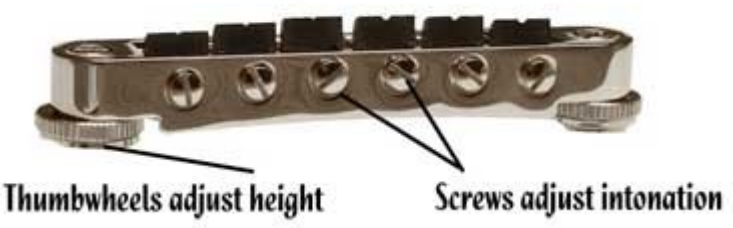
Using Electronic Tuners

When one is first learning to play, tuning an instrument properly can be quite the task. For that reason most of us start out using instrument tuners until we develop an ear for tuning.

Common Instrument Tunings
(Largest String First)
Guitar **E A D G B E**
4 String Bass **E A D G**
5 String Bass **B E A D G**
6 String Bass **B E A D G C**
Mandolin **GG DD AA EE**
Ukulele **G C E A**

Electric Guitar Bridges

Tune O Matic (TOM) Bridges



The saddles on a tune-o-matic style bridge are raised and lowered as a unit. The outer thumb wheels beneath the bridge control it's overall height.
Each saddle has a screw which permits forward and backward movement that enables us to adjust string length, which setsintonation.

ABR or Nashville?

The Gibson® Tune-O-Matic style bridge comes in different styles which can lead to confusion. While there are several differences an easy comparison is the mounting post.

The **ABR's** bridge post are an all threaded rod and use a thumbwheel for height adjustment.

Gibson ABR style saddle

The **Nashville TOM bridge** uses inserts which are installed into the body, the bridge post then screws into the inserts for height adjustment. They are threaded at the base and normally solid (un-threaded) at the top.
Other noticeable differences:
Nashville bridges are wider from front to back, which increases the travel of the saddle. This gives us a greater range for adjusting intonation.

Chrome Or Nickel?

Nickel parts tarnish over time and will begin to look dull. This is often preferred on vintage instruments.
Chrome plating remains shiny and does not tarnish. When comparing two new parts (chrome vs. nickel) you may notice chrome looks more "blue", while nickel appears more "yellow".

Tremolo Style Bridges

Bridges, such as those commonly seen on Fender Stratocaster's have two large screws in the front which the assembly pivots (rocks) on. These also control how far above the body the bridge sits. Individual string height and intonation is also available. Each saddle has two small allen head screws which act as feet and control the saddle's height and therefore the string height.
A single screw, towards the back controls string length and intonation.

Floating Tremolos

The Floyd Rose® style floating tremolo has lovers and haters. While it may the right tool for the job, it doesn't come without it's fair share of headaches. For those not using their floating tremolo, it is a simple matter to block the tremolo and essentially make it a hardtail.

Fine Tuners

On the top of the bridge are 6 small thumbwheels which serve as fine tuners. Because most instruments equipped with these tremolo's also incorporate locking nuts, tuning must be done at the bridge.

String Lock Down

To the rear are allen head screws which press against a small block inside the bridge's saddle which acts as a **vice** for holding the end of the string securely.
When replacing a string, the screw is loosened and a new string (minus it's ball end) is inserted into the space in front of the small block. The string lock down screw can then be tightened.

Saddle Mounting Screws

Loosen one of these and your saddle may go flying forward, wreaking havoc on the intonation. These screws clamp down on the saddle and keep it in place. They are loosened when intonating the instrument requires the saddle's position be moved forward or backward. Most bridges have two holes in the plate beneath the saddle to permit greater flexibility of positioning. If

intonating the saddle requires it be moved considerably, changing holes may be required to allow the saddle mounting screw to contact the saddle firmly.

Guitar Electronics Repair

Skip to: Pots | Switches | Jacks | Wiring | Shielding | Soldering

Volume & Tone Pots (Potentiometers)

Cleaning

A scratchy sounding pot could be a sign that dirt or corrosion is effecting the contacts inside of the pots casing.

Pots can be cleaned by spraying into the open area of the pot below the soldering lugs.

In order to clean the pot you will need to spray contact cleaner into the opening of the case.
I prefer DeoxIT as it comes in both a spray, which adds pressure to "blow" junk out of the case, and a bottle, which provides precise application when trying to avoid a mess.
Now turn the knob repeatedly to allow the cleaner to thoroughly "scrub" at the contacts.
Badly worn or defective pots will remain scratchy or intermittent regardless of vigorous cleaning and should be replaced.

Replacing Pots

"Pot" stands for potentiometer. Volume and Tone pots are the same component but a capacitor is soldered to the ground lug of the tone pot. This cap prevents a certain amount of treble from grounding out.

Using The Right Potentiometer

- Linear and Audio
- Resistance OHM's (250K, 500K, 1meg etc.)
- Split shaft or solid shaft
- Long thread or short thread
- Size (Mini or Standard)

When replacing a volume or tone pot you need to know the specs of the pot you are replacing.
You can measure a functioning pots resistance using an OHM meter. Attach a lead to each of the outer lugs, rotate the pot fully in both directions and take an OHM reading of resistance.

Tone vs. Volume Pot

Many manufacturer's use the same pot for both volume and tone. Others may use Audio Taper for volume and Linear Taper for tone.

Linear vs Audio

Linear taper pots are marked with an A (ex. A500k, 500KA). Audio taper pots are marked with a B or Lin.

Using an OHM meter attach one lead to the outer soldering lug and one to the center lug. With the pot rotated to center the resistance will equal to 1/2 of the pots total resistance if it is a linear pot.

OHMS (Value/Resistance) 250K, 500K, 1MEG

Pots are given values according to their resistance which is measured in OHMS. Check the wiring diagram or original pot casing for value.

> **Checking A Pots Resistance** - Using an OHM meter, attach the leads to outer soldering lugs. Rotate the pot fully to measure resistance.

Long Shaft vs. Short Shaft

Long shaft pots are often necessary when the pot is passed thru the actual top of the instrument. (ex. Les Paul). Short shaft pots are used when mounting directly to a thin pickguard. (ex. Strat)

Split Shaft vs. Solid Shaft

The type of shaft used on a pot dictates the types of knobs that can be used. Solid shaft pots are ideal for knobs which are secured by a set screw thru the side. Split shaft pots use knobs which press on.

Solid & Split Shaft Pots

A small brass sleeve can be used on a split shaft pot to accomodate screw on knobs.

Mini Pots

While you could use a mini pot in place of a standard size pot, these are most often seen on instruments with active electronics and cramped control cavities. .

Push/Pull Pots

Serve as a traditional rotating pot as well as a switch which is actuated when pulled up and pushed down.

Multi-Function Pots

Multi-function pots such as push/pull and stacked or concentric pots add an additional function to the pot. They can be used when limited space is available or no additional holes are desired.

Removing press on knobs with rag

Removing press on knobs with guitar picks for leverage

Switch Replacement

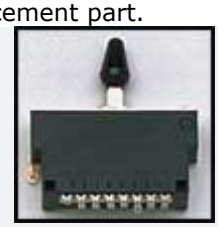
There are a number of different switches being using on electric guitars today:

- 3, 4 and 5 way selector switches
- Toggle switches
- Push/pull switches
- Sliding switches
- Multi-function pots

5 Way
Selector Switch

Worn switches can suffer from a variety of symptoms including popping and scratchy sound, sloppy movement and intermittent or total loss of connection. Because some of these can also be symptoms of a loose wire or corrosion the switch should be cleaned with contact cleaner and all wiring connections checked.

Replacing a bad switch can be as easy as removing the wire from the faulty component and soldering it to the same lug of the replacement part.



5 Way Switch
Found On Some Imports

If the connections of your replacement part do not match the original switch make sure you are using the correct part. The black 5 way switch on the right is often found in import guitars. While I recommend upgrading when possible, some switches will not mount up properly due to differences in screw layout.

Output Jack Repair

We have two common problems with output jacks, one is **a broken wiring connection**. (See below for connections). This happens easily once the jack becomes loose as it can twist just enough to pull the wires loose.

The prong often looses it's "spring"

A second common problem we encounter is **a poor mechanical connection**. When inserting a cord into a jack, the click you feel is the tip of the cord seating against the metal prong on the end of the jack. With use this prong may spread outward and loose a bit of it's tension. A gentle bend of the prong may be just enough to create a solid connection, however, metal fatigue can dictate the need to replace.

Soldering Connections

On a mono output jack you will find two soldering lugs, one for the ground (frequently black), the other for the hot wire. The hot wire is often coming from the center lug of the volume pot. When viewing an output jack you can follow the lug's path ...the hot wire lug will lead to the prong, the ground lug will lead to the center of the jack.

Wiring Repair

Most often this is a problem on vintage instruments who have seen better days or those that have been improperly repaired. Loose wiring, cold solder joints, broken connections and burnt insulation can all cause problems.

By far the most common wiring problem is broken wiring at the jack. The jack must be kept secure or it may begin to rotate when the cord is installed and removed. Eventually a loose jack may twist the wiring until the connection is broken.

Cold solder joints can be a bit of a mystery as hazy dull solder is not always apparent.

Check each wire for bare spots and missing insulation to insure it can not ground against another component.

Soldering

The web is a great resource that can give you the basics on soldering but if you doubt your ability I would of course recommend letting a shop handle it for you.

When soldering parts on your instrument make sure to cover the body and protect the paint as solder loves to spit and pop. A hot blob of solder on the paint makes a nifty crater you may not want.

Small alligator clips serve as heat sinks.

Heat Sinks

Heat sinks should be used to prevent heat from damaging vulnerable capacitors and other components. I will place a small alligator clip on the capacitors wires which will dissipate some of the heat that would normally pass straight to the capacitor.
A bare area in the wire can ground to other metal components and create shorts, be careful to avoid contacting other wires when soldering in cramped cavities.

Cold Solder Joints

When making solder joints to switches and pots, the **lug** and wire should be heated by the tip of the iron and the solder pressed (or flowed) onto the joint. In this manner you can avoid cold solder joints as both components are properly heated prior to the application of solder. Melting solder on the tip of the iron does not insure the actual components are being heated properly.

Shielding

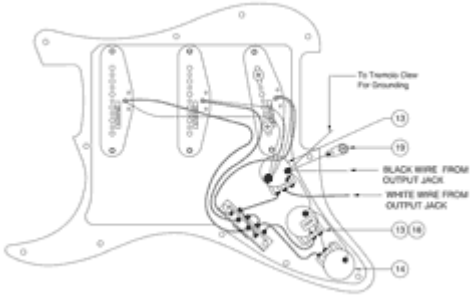
Electric guitar pickups can pickup frequencies from many sources. Most common interference is caused by florescent lighting, computer screens, power pack adapters and other sources.

Shielding lines the routed cavity as well as the back of the pickguard.
A "tab" is used to complete the connection from cavity to pickguard.

Shielding an instruments electronics cavity is one way to reduce interference and 60 cycle hum. Single coil pickups are notorious for humming and shielding may help to improve the situation. There are some pickups however that are just plain noisy and show little improvement regardless of effort (short of replacing them.)

Shielding is done by lining the instruments control cavity with special adhesive backed copper foil, though heavy duty aluminium foil sprayed with adhesive can also be used.
When overlapping multiple pieces of shielding a drop of solder is used to ensure continuity.
A "tab" of shielding is brought over the edge of the cavity which serves as a bridge to connect the shielded cavity with the shielded pickguard. I place this tab over a screw hole so the screw pulls the two pieces of cooper together.

Wiring Diagrams



Many web surfers contact me looking for a wiring diagram for an unusual / no name / import guitar after having no luck online. And sometimes you aren't going to find it, however, if you have an electric guitar that is similar to lets say a Strat ... it has 3 single coil pickups (and they are 2 wire pickups), one 5 way switch, 2 tone pots and 1 volume pot then you can simply use a Strat wiring diagram. It's often easiest to think of the instrument in terms of components not brand.