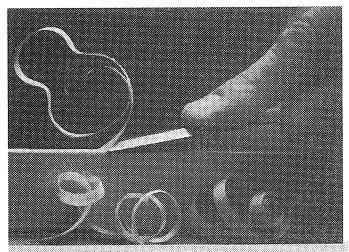

Guitar Player® Repair Guide

How to set up, maintain, and repair electrics and acoustics

Updated & expanded second edition

by Dan Erlewine

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Dedication

Dedicated to Joan, Meredith, and Kate–with love.

Also thanks to:
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Jas Obrecht, the greatest editor a guy ever had and a patient amigo.
Bryan Galloup's Guitar Hospital in Big Rapids, Michigan, where many of the photos were taken. And to all my customers: thanks for breaking your guitars!

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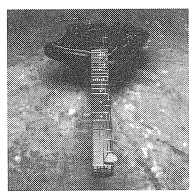
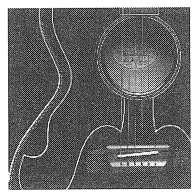
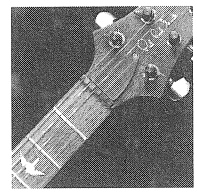
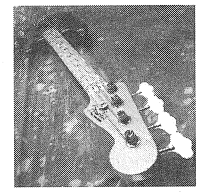
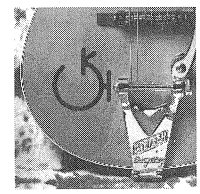

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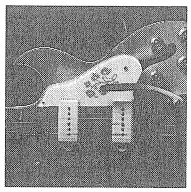
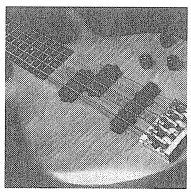
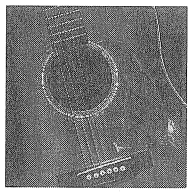
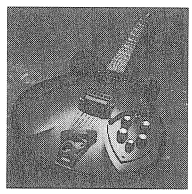
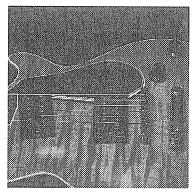

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Foreword

Among material objects on this earth, few possess the mysterioso voodoo of the guitar. From the moment we first pick it up, there's something about its feel, its look, its heft, that whispers—or screams—to us. Before long this intriguing stranger becomes a friend, even an extension of ourselves, and we feel the urge to nurture it, to take care of it, to caress it. Or maybe to rip out its pickups, bolt a whammy bar on there, and spray it with metalflake green enamel.

We can't keep our hands off the guitar. If we're not playing it, we're polishing it, adjusting it, altering it, or wondering about it. Why does it buzz when I bend a string? Would it get more sustain with a brass nut? How come it doesn't play in tune anymore?

Whether you want simply to maintain your guitar in performance-ready shape or hot-rod it into a radical new incarnation, Dan Erlewine is the ideal guide, guru, and godfather. He's a player, he's an extraordinary repairman, and he gets to the point.

Erlewine's credentials run deep. He was co-founder of Erlewine Instruments and proprietor of Dan Erlewine's Guitar Hospital in Big Rapids, Michigan, and is currently the author of *Guitar Player*'s popular Repairs & Modifications column, as well as Director of Technical Operations for Stewart-MacDonald's Guitar Shop Supply in Athens, Ohio. He's also produced numerous acclaimed how-to videos.

This is Dan's personal edit of his Guitar Player columns—adding in new stuff and removing out-dated information. And far more than that, too: it's the product of thousands of hours spent hunkered over wounded guitars, a smoking soldering iron in hand. It's the product of experimentation and improvisation, endless hours poring over books and manuals, consultations with top repairmen, and countless weekend seminars, trade shows, and lutherie conventions. In short, it's the life work of a talented craftsman who loves his work. You'll find the good advice that all guitar owners need to know, plus loads of up-to-minute tips on new-generation whammies, finishes, acoustic pickups, and a whole lot more.

Over the years Dan's clients have included gifted, demanding players like Mike Bloomfield, Clarence White, Otis Rush, Johnny Shines, and Ted Nugent. Jerry Garcia owns one of his Strat-style electrics, and Albert King was pictured on the cover of *Guitar Player* with Lucy, the V-shaped electric blues machine that Dan custom-built for him.

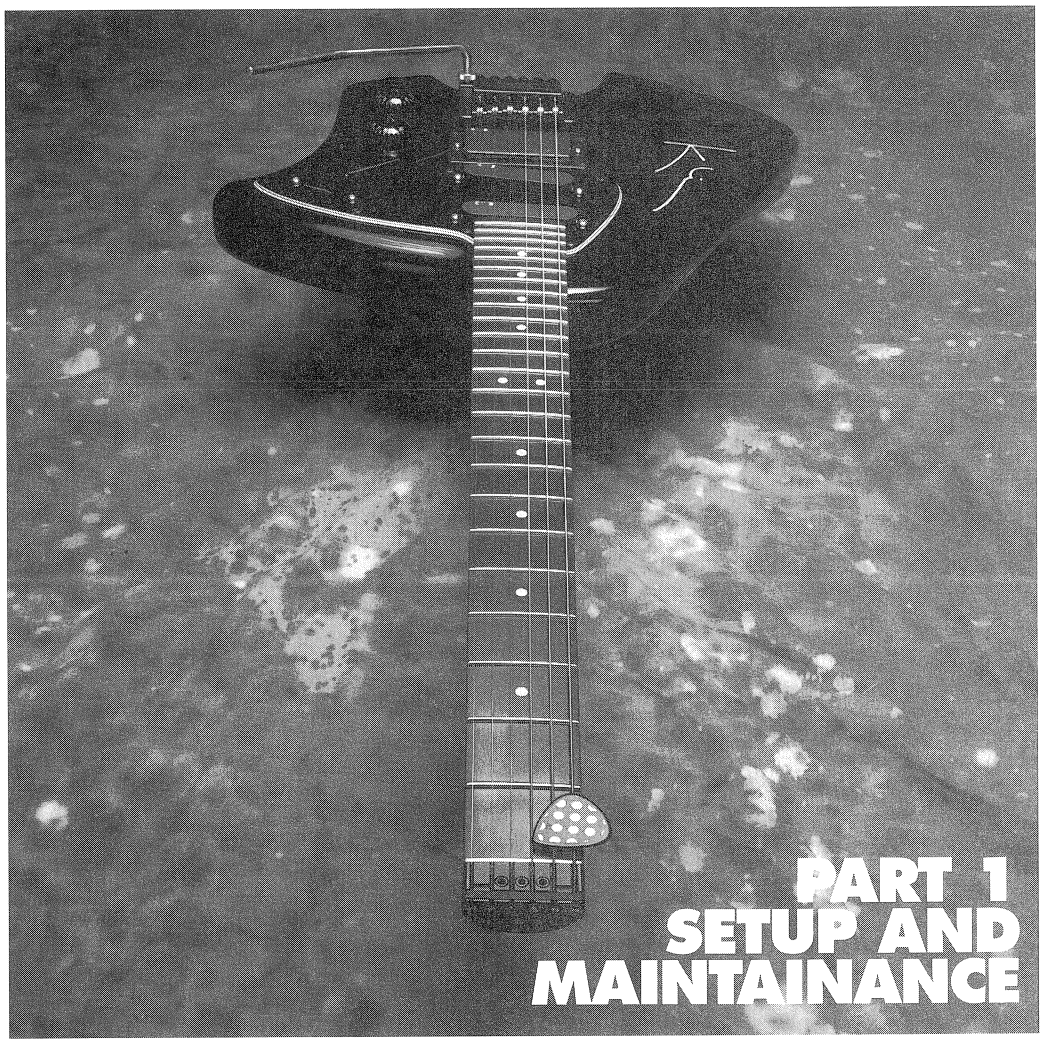
Dan Erlewine has helped all these players and many more to get the most out of their guitars. Now it's your turn.

Tom Wheeler
Editor
Guitar Player Magazine

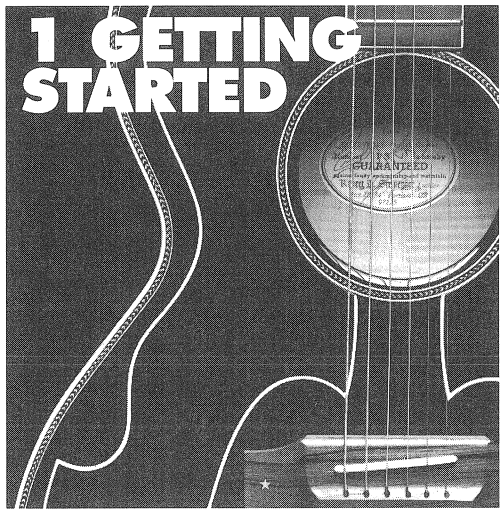
Introduction

Every guitarist wants an axe that plays easily, stays in tune, looks and sounds good, and is set-up correctly, right? And when things go wrong, important repair decisions must be made. Who'll fix *your* guitar? Should you get a second opinion? Since 1985, my *Guitar Player* column Repairs & Modifications has looked at guitar repair and set-up from many angles. This book updates those columns for the '90s, condensing and organizing them into a manual for guitar players and repairmen. It teaches do-it-yourselfers to fix guitars, helps players keep their axes sharp, and gives advice that will help you choose a good repair shop when the chips are down.

The Set-Up and Maintenance section is for players of all levels. Beginners suspect that learning to play is easier on a well-set-up guitar, and they're right. Professionals discover that by personally setting up their own guitars, they finally realize every inch of its potential—but only after making such fine adjustments as setting the intonation and adjusting the "action" themselves. The Acoustic and Electric Guitar Repair section is for everyone—take what you need. Fellow repairmen are sure to find new tricks of the trade, and players: just *knowing* about guitar repair may keep you from the heartbreak of seeing your guitar ruined by inexperienced hands.



PART 1
SETUP AND MAINTAINANCE



Cleaning the finish

Imagine that you've just bought a great used guitar. It's filthy and out of adjustment, but underneath the crud you know it's in excellent condition. I've come across many such guitars over the years, and to get them in shape I always follow the steps outlined in this chapter. First clean the finish, to start out fresh and see what you've got. Then, before installing a new set of strings, clean the fretboard and any dirty or rusted metal parts (most often the bridge). String it up and adjust the neck. If the bridge is adjustable, set the intonation. At this point, if your new axe plays great and satisfies your needs, you're done! If it doesn't play great, you may have uncovered a number of problems during the basic maintenance stage. The rest of this book will help you take care of those problems. Good luck!

Cleaning and polishing a guitar is the most basic maintenance task of all, and every player should know how to go about it. Maintaining a new instrument's clean good looks is simple if you keep it up from the beginning. But the lucky player who "discovers" a vintage piece that's perfect except for a finish that's been dulled by years of sweat, dirt, and exposure to barroom smoke and the elements may need the helpful information in these pages.

Guitar finishes become dirty and hazy because dirt particles come to rest on the finish, which always has a thin film of oil on it no matter how often you clean it. Some of these oils come from your body, while others become suspended in the air from cooking, manufacturing, pollution, etc. The oil and dirt create a "build" on the finish, which hardens in time and is quite tough to remove. When you remove the dirt, because of its abrasive qualities, you could be removing the finish too! That's why using the right cleaning technique is important.

The tools needed for cleaning and polishing new or used guitars are few, simple, inexpensive, and easy to use. Clean soft rags are the most important tool, and depending on the situation, you may also need any of the following: naphtha, liquid guitar polish, "swirl-

If you would rather not use chemicals to clean your guitar, try the moist-breath trick or use a saliva-moistened rag wrapped around your fingertip.

Remember: Don't rub your guitar down too much, even with just a rag. Polishes are more gentle than cleaners, and be very careful when working on old finishes!

mark remover," liquid abrasive cleaner, warm water, and elbow grease. First, I'll describe each cleaner and explain why it's used, and then follow with a few cleaning tips. As you'll see, lemon oil and silicone products are to be avoided.

EVERYTHING YOU'LL NEED

■ Clean, soft rags head the list. With several rags and plenty of time, you can clean the dirtiest guitar without polishes or cleaners, although polishes and cleaners help you do a faster, better job. The three best cleaning rags are: used, well-cleaned baby diapers, cotton T-shirts, and 100% cotton flannel. The soft rags that many manufacturers imprint with their company logo and include with a new instrument are made from flannel. You can also buy a yard of flannel at any fabric store for $3.00. Most other rags and fabrics are too coarse for delicate guitar finishes.

■ Naphtha (lighter fluid) is a great, all-around guitar cleaner. It's a de-greaser for finishes, pickguards, fingerboards, bridges, tailpieces, and metal parts of all kinds. Used lightly on a rag (more dry than wet) it won't harm a delicate lacquer finish, and certainly not polyurethane or polyester finishes. Naphtha leaves a flat, dry haze on a finish, but it's generally used first in the cleaning process, so guitar polish or a dry rag brings the sheen right back.

■ Guitar polish. The creamy stuff in the little plastic spritz jars is a *cleaner* because it's a liquid with an extremely fine abrasive. The liquid washes, and the abrasive lifts dirt. It's a *polish* because there's wax in it that protects and shines. The right polish won't scratch a finish. Martin makes a good polish/cleaner, and you can trust them to recommend something safe for high-quality guitar finishes, especially lacquer.

■ Swirl-mark remover is similar to liquid polish, but without the wax; it's actually a cleaner with an extremely mild abrasive. Swirl-mark remover is used in the auto industry for the final polish of newly-sprayed finishes. A good brand is Mirror Glaze #9 —it's a delicate, excellent cleaner that even without wax leaves a nice shine. I have found that #9 does not give good results on water-base finishes. It may dull them—not the desired effect!

■ Liquid cleaners are light-duty buffing compounds made with a mild abrasive but no wax. Cleaners are best for dirtier finishes, since the absence of wax allows unlimited cleaning time without the wax drying (along with the dirt) at every polish-stroke. The abrasive is coarser than swirl-mark remover or guitar polish, so it does a good job of removing heavy dirt buildup. Cleaners won't leave scratches, but as soon as the dirt lifts, switch to a milder polish or swirl-mark remover—you don't want to rub away more finish than needed! Two good cleaner brands are Mirror Glaze #7 and Martin Seynour's Buff-eez #6355.

■ Lemon oil, while not on the list, is highly touted by some as a polish for guitar finishes, but I avoid it because it feels as though I'm wiping kerosene onto the finish. I believe that lemon oil works its way into and under the finish, especially on older vintage instruments with a lovely checked patina. This could cause the finish to lift and the wood to become saturated with oil—possibly dampening tone. Lemon Pledge should not be used on guitars!

■ Silicone is definitely not on the list, but it's added to some polishes and cleaners. Polishes or cleaners with silicone should be avoided! ArmorAll, which has silicone, is used by many music stores to keep guitar cases looking spiffy, but they should avoid it. Lacquer, glue, stain, and all sorts of guitar repair items just don't get along with the slippery aftermath of silicone, and subsequent repairs to an instrument exposed to silicone will be a hassle.

■ Warm water, used sparingly (your cleaning rag should be slightly damp—not sopping wet!), works wonders. Don't force water into checked, dry, or weathered finishes. Saliva is an excellent cleaner, too (seriously)—but only if you're working on your own guitar. Elbow grease needs no introduction, so let's get on with the work.

Polishing is what you do to a guitar that isn't really dirty, and the process doesn't have to involve *polish* at all. A clean, dry rag may be all you need to keep a new guitar's finish in shape by wiping off sweat and oil before they get a

chance to build up and oxidize. Occasionally use the liquid guitar polish for its protective wax coating—but only on newer finishes which aren't weather-checked. Before polishing or cleaning, be sure to wipe, vacuum, or blow any *gritty* particles from your finish; otherwise you'll drag them around on the surface, causing scratches you'll never get out!

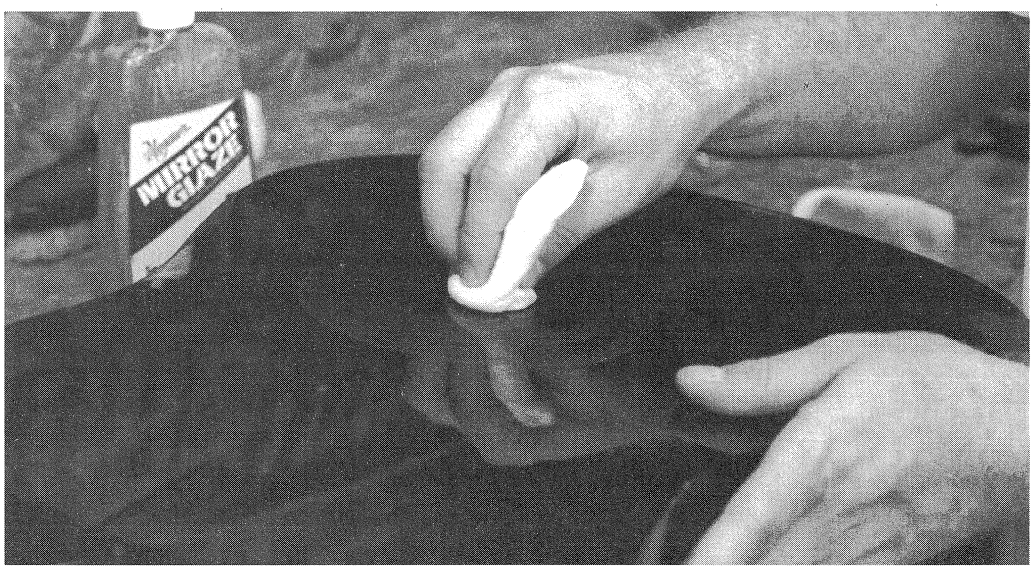
Polishing an extremely dirty guitar doesn't make sense. You don't polish dirty instruments; you clean them first and *then* polish. Since guitar polish is also a cleaner, it takes care of both jobs at once if the finish isn't too bad. But cream polish also puts a nice shiny film on top of the dirt if you're not careful. And with polish *or* cleaners, it's easy to just move the dirt around without transferring it to your rag. Remember, getting dirt off the surface of the finish and onto your rag is the object! There's a knack to getting dirt to transfer, especially on old guitars where it's heavily oxidized. Here's how you do it.

CLEANING

Take a 4" x 6" section of a clean, dry rag, fold the corners into the center, and grab the rag like a "knuckle-ball" (bunch the corners and loose parts into your palm, so that the fingers and thumb are pinching the rag into a ball shape as in the photo below). In the finishing world this ball of cloth is known as a tampon, "frenching-pad" or "pad," and is used for French polishing, which is the art of applying a shellac finish by hand-rubbing. This ball of cloth is a good tool for cleaning and polishing your finish. Use it with polish, naphtha, water, or cleaner, or use it clean and dry. A true French-polishing pad has a ball of cotton in the center to hold finish and to help the pad hold its shape. The best pads are made from lint-free cloth (old linen bed sheets are great if you can find them).

There are no strict rules for cleaning, but here's the "hi-tech" method I generally start out with: Get very close and blow your warm, moist breath on the area until it fogs up, then quickly polish off the dirt; it'll transfer to your rag. If the "moist-breath" treatment doesn't remove all the dirt or haze, follow with a pad dipped lightly in naphtha, since it breaks down grease and sticky residues. Then follow with a pad dipped in water (it's a toss-up which to start with, naphtha or water). What naphtha or water won't remove, a polish or cleaner will. *Note: Naphtha is a petroleum product, and you should wear plastic gloves and safety glasses when using it. Work in a well-ventilated area and keep away from sparks, electric heating coils, or open flame.* Give the whole instrument (or any area to be cleaned) a light wiping with naphtha before switching to a polish or cleaner.

After the naphtha-wash, use polish or cleaner (depending on the situation) and work small (4" to 6") areas at a time. As the dirt starts to loosen or "move," pick it up onto the face of your tampon with a quick upward twist of the wrist. When one side of the rag gets loaded, switch to a clean part; otherwise you'll put the dirt right back onto the finish. Remember, the finish, rag, *and* dirt are all warm from the friction of



rubbing, which allows the dirt to either lift away from or return to the finish. Another cleaning trick is to move the dirt off to an edge, where you can pick it up more easily.

Let's look at a typical cleaning job. Let's say the top edge of your Les Paul is sticky and showing some dirt where you rest your arm or picking hand. This type of hazy buildup can usually be removed without polish, using only a clean dry rag, so always try the dry rag first! Rub lightly in either a straight or circular pattern (circular motions blend in best). If you're not getting the dirt onto your dry rag, pour a dab of polish onto the rag's face or directly onto the finish and continue rubbing, following the directions on the bottle (some polishes are wiped on and left to dry, some are rubbed off immediately).

Vintage guitars must be given special consideration. Often the "moist breath fog" is the best technique for extremely thin finishes that are riddled with finish-checks, since you don't want to work polish or cleaner down into these crevices. A *light* naphtha wiping is okay—"light" meaning that you tamp off the wetness onto another rag and wait until the naphtha starts to evaporate before wiping.

Warm water has its place in cleaning vintage instruments. If I use water, it's only to *dampen* the rag, which is wrapped tightly in one thin layer around my index finger. Sometimes a barely damp rag can be a big help in removing dirt or haze from a vintage piece where you're afraid of working any petroleum-based chemicals into a checked finish. You must be cautious of working water into a crazed finish, so it's a judgment call. Use the same light French polishing motions that you used with the tampon, just barely hitting the surface to pick up the dirt. And I hope this won't gross you out, but when nothing else works, saliva (spit!) can often dissolve the weird globs or specks fused to a finish! Of course, I'd never use spit on a customer's guitar—only on my own instruments.

Beware of soft finishes! This rare phenomenon occurs with lacquer, varnish, or the shellac-based French polish which was used on most instruments made before the 1930s. It's still used today on many of the world's finest classical guitars. Have you ever sat in a nice wooden-armed chair and felt that sticky, gummy surface that wants to stick to your skin? When you *know* that if you dragged your fingernails along the finish they'd be loaded with sticky, grimy sludge, *that's* a soft finish.

Finishes get this way because there are natural plasticizers (triglycerides) in your body that transfer through the skin—especially your hands. Lacquer "breathes," allowing moisture and certain chemicals such as polishes, cleaners, and plasticizers to migrate through it. The plasticizers go right through the finish and make the wood their home. Once a finish is softened this way, there's no cure except letting it totally air dry, and even then it may never be truly hard. The most common area of a guitar to suffer from this is the part of the body where you rest your arm when playing, although you may also see it on the neck or other areas. It's most common on dirty guitars that weren't cared for, since the oxidized dirt acts as a lid, holding the plasticizers down in the finish so that they can't migrate. If your axe suffers from these symptoms, I'm sorry, but don't try to rub, clean, or polish it away—it'll just make it worse.

POLISHING SCHEDULE

How often should you clean and polish? When should you use a liquid cleaner or guitar polish rather than just the dry rag? I haven't seen your guitar, so I can't tell you. I can only offer you some ideas:

Polyurethane or polyester (catalyzed) finishes seem impervious to anything; I suppose you can clean and polish them until the cat comes home. New guitars with lacquer finishes (ask your dealer what type of finish is on the instrument) can stand up to cleaning or polishing quite well, since the finish surface is smooth and unchecked. Remember that lacquer "breathes," so when you rub polish onto your finish, you're rubbing it *into* the finish as well. Regular polishing helps keep the finish new-looking and makes it less prone to checking, because of the chemical nutrients in the polish.

I always clean a used guitar right after I buy it, since I haven't found a clean one yet, and I don't like someone else's dirt on my guitar. When possible I clean with naphtha and a dry

rag, but often a liquid cleaner is necessary. I don't use commercial guitar polish, because I'm afraid of the wax penetrating a thin vintage finish. After the initial cleaning, I may not use polish or cleaner on a used guitar for up to three years—sometimes longer. But I will use a dry rag every few months, or whenever the finish gets sticky. I really can't get too excited about rubbing any sort of liquid *on*to—or *in*to—a thin vintage guitar finish, since I don't want to do anything that might change them. Polishes are for new guitars.

Polishes and cleaners are formulated to penetrate a finish and rejuvenate it to a certain extent, adding essential nutrients that keep it softer, shinier, and more flexible. Polishes and liquid cleaners help to delay the aging process, and can keep your finish from becoming overly brittle. However, I happen to *like* a dried-out finish on a 1930s Martin. And I *like* a dried-out finish on my 1944 Gibson J-45!

I believe that dryness and brittleness are part of the reason old guitars have killer tone, so if you clean and polish a new guitar regularly, after 30 years the finish is less likely to be dry and brittle. It will look better, but may not sound as good as a guitar that was dry-polished (or given the moist-breath treatment) somewhat regularly but liquid-polished or cleaned only occasionally.

You now know enough about finish cleaners and techniques to handle anything. Keeping the strings and fingerboard clean after playing is important, too—that's coming up next, and it's not nearly so complicated!

Cleaning your fingerboard

The condition of a guitar's fingerboard is essential to the quality of music that the instrument can produce. Although a warped neck or bad frets are often best left to your repairman, there is one job that any player can perform—cleaning the fingerboard. A clean fingerboard produces clean-sounding music; dirt, however, hampers smooth slides and fast playing. Dirt can also destroy, slowly rotting the wood and eventually causing the frets to work loose. Whenever I change strings, I always give the fingerboard at least a quick cleaning. There is a fine balance between a dirty fingerboard and one that has absorbed just the right amount of natural oil from your skin. A too-clean fingerboard wouldn't please many players. Decide for yourself; but if you need to clean your fingerboard, here's how.

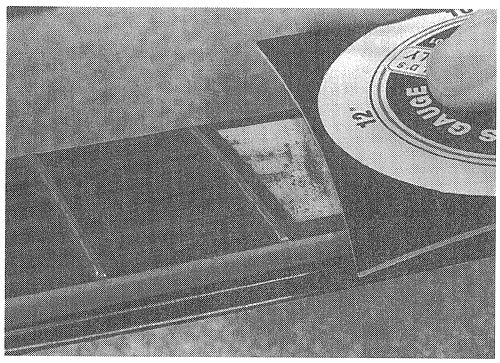
KEEPING YOUR STRINGS CLEAN

When grime and dirt have built up along the edges and between the frets and the wood itself, the board requires a thorough going-over. However, if you wipe your strings clean after playing, there will be less chance for dirt to build up. Years ago, when I was playing six nights a week alongside a pedal steeler, I noticed that he would clean each string at the night's end, using a special rag called a Blitz cloth, which was commonly used by the Army to polish brass. I started using one, too, and found it to be the greatest string cleaner I'd ever seen. An Army surplus store was the only place I could find them. Since that time I have seen them in music stores being sold as String Care by Blitz.

When cleaning strings after playing, be sure to lift each one out of the nut slot and off the bridge saddle, wiping that part of the string with your Blitz cloth, too. You may have to tune down slightly to do this. Once the strings are wiped and still a little slack, get in between them with a soft rag (not the Blitz cloth) and wipe down as much of the fingerboard as you can reach to get rid of the sweat. Occasionally use your thumbnail to press the rag into the crevice along the fret/fingerboard joint. This is where the wood can rot, since the fret slot (the groove that a fret is set into) has exposed end-grain and will soak up any sweat and dirt that work their way under the fret. If you clean your strings faithfully—especially after a night's playing in a club or a long practice session—your fingerboard should only require an occasional polish with a soft, dry rag.

REMOVING HARDENED DIRT

Cleaning a filthy fingerboard is a different story. *(Note: If you own a guitar with a maple fingerboard, read the caution below before*

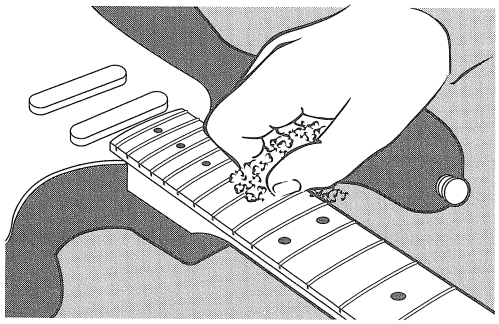


A Blitz cloth is great for cleaning the strings after a night's playing. Look for *String Care by Blitz*.

proceeding.) If the grime has accumulated for a long time, it may have hardened, and steel wool alone won't remove it. In this case, you'll have to scrape it off carefully. Be sure to use a scraper that won't cut into the wood and leave marks. In some cases you may wish to soften the dirt before trying to scrape it away. Use a Q-tip dipped in naphtha to wet the dirt and help loosen it. Then follow with your scraping tool—I prefer a plastic radius gauge of the type used for measuring fretboard arc (radius gauges are explained early in chapter two). Held at an angle, the radius touches all the board at once and removes the dirt like a snow plow removes snow (photo above). Also, its sharp tip is perfect for getting into that tight fret/fingerboard corner where most of the dirt cakes up. We'll talk more about a radius gauge under "Setup" and "Fretting."

CLEANING AND POLISHING WITH STEEL WOOL

Pinching a ball of 0000 steel wool the size of a golf ball between your thumb and index finger, push down with your thumbnail against the fret/fingerboard joint. This will clean right into that corner and smooth and polish the fret edges. 0000 steel wool is quite gentle—but still, try to avoid making excessive crosswise marks in the wood fingerboard. Since you've already steel-wooled the fret/fingerboard joint, the fret is partially polished (on the sides). To finish the job, press your index finger on the steel wool again and rub back and forth on top of the fret to bring it to a good shine. This fret polishing is done along the fret's length (crosswise to the fingerboard). Finally, to remove any slight crosswise marks left by the fret polishing, use a fresh ball of wool to rub the entire fingerboard—wood and frets—in one direction, going with the grain along the entire fingerboard's length. Now the board should have a smooth, satiny look. Remember: Use only 0000 steel wool; nothing else is fine enough.

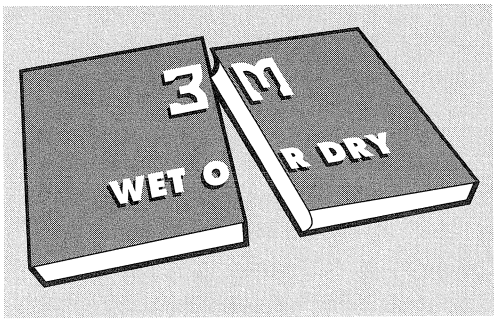


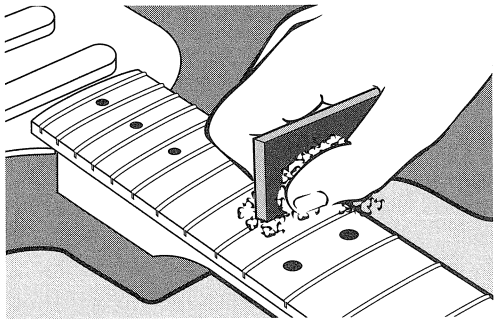
Two cautions: 1) When polishing frets across the grain, I lay down not-too-sticky "drafting" tape (a type of masking tape available from art supply stores) to avoid cross-marks in the wood. When removing the tape you could pull finish from the fingerboard edges. Refer to the chapter on dressing frets for more in-depth information! 2) If you own a guitar with a maple neck—i.e., a maple fingerboard with a clear finish—don't use steel wool or a scraper on the finish! Use only a soft rag. For hardened dirt, dip the rag in a little lighter fluid if necessary; mostly, you will need a lot of elbow grease. And don't use the lemon oil mentioned below on a maple neck—it doesn't need it! Tape off the lacquered wood with masking tape while cleaning the fret/fingerboard edge or polishing the fret tops. You may use steel wool on the finish, but it will remove the gloss and leave a dull, satiny finish. Some customers ask me to "degloss" their fingerboards in this manner, since they feel it leaves the surfaces more comfortable to play.

CONDITIONING THE FINGERBOARD WITH OIL

After the cleaning operation, I occasionally apply a dab of lemon oil to the fingerboard, using a soft rag. I'm not advising you to use the oil every time you change strings; use it only when the board is in need of it—several times a year for the average player. If the wood seems exceptionally dry after cleaning, it needs the lemon oil. Likewise, don't use steel wool each time you clean. Don't overdo it. I change strings every week when I'm playing on the weekends, but since I always clean my strings after the last set, I need to steel-wool the board only every month or so.

Here's a tip for tool lovers. Take a rubber squeegee (a 3M product used to remove water when wet-sanding cars, available at auto supply stores), and cut out a piece 1½" by 2½". With a small round file, make a slight groove





on the long edge. Wrap the steel wool pad around your new homemade fret polisher, and use it as you would your finger (above). This tool saves a lot of wear on your fingertips and thumbnail when working the steel wool.

Cleaning and de-rusting metal bridge saddles

At one time or another, most of us run into rusting, dirty, and corroded "adjustable" bridge saddles that no longer move. As a result of wear, sweat, or corrosion, some bridge parts may be beyond repair. But many bridges, saddles, screws, and springs end up being junked unnecessarily when, with a little care, they could most likely be made to work. Here's advice on breaking rust joints, removing caked dirt, and on cleaning, degreasing, and lubricating metal bridge parts in general. I'll use the Fender bridge as my example, since it is both height- and length-adjustable, and therefore has more parts that may require cleaning. But all electric guitars, from Gibson to Ibanez, are prey to the dreaded crud monster. These techniques for cleaning, rust-breaking, and lubrication work on all metal electric parts (not just bridges) and won't harm a vintage piece when used with care.

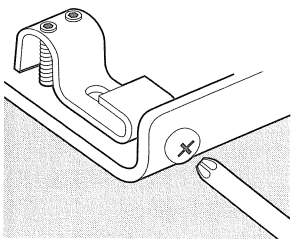
Don't get carried away with polishing to the point where you wear out your fingerboard and frets. Be reasonable, and just don't be a total slob.

There are two likely rust problem areas for electric bridge saddle inserts: at the height-adjusting screws that raise and lower the saddle and control the string height, and at the length-travel screws that are used for setting the intonation. Of course, the basic bridge body, which is usually a stamped or die-cast housing that the saddles sit on or in, needs to be cleaned, too. This is much easier to do if you can remove the parts first.

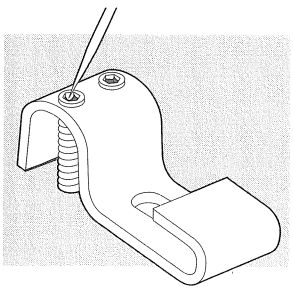
Whenever possible, remove the bridge from the guitar (with a Tele, gently remove the pickup first—or clean the bridge in place). Then, before trying to disassemble any parts, preclean them with naphtha (lighter fluid). Pour some into a jar and apply a wet coat to the saddles, screws, and springs with a small, stiff brush or toothbrush. *Remember to wear safety glasses, and work in a well-ventilated area!* You may submerge the whole bridge in naphtha if you wish. After the parts have soaked awhile, remove as much crud as possible with a dry toothbrush. An air compressor can be a great help in blowing out dirt, if one is handy. Next, apply more naphtha with a little light oil added to it—the two mix together, with the naphtha thinning the oil and helping it run down into rusted threads.

Now, before turning any screws, clean the Phillips or flat-bladed screw heads. Remove as much dirt and rust as possible. I use the sharp end of a straightened-out dental probe to scrape the walls; a pin, needle, or sharp X-acto blade also works. Slot heads are easy to clean, but the Phillips type require more work. Often the Phillips' criss-cross slots are partially stripped from removal attempts made when the head was packed with dirt. In this case, even cleaning the head won't allow the screw-driver to get a grip. Screw extractors work best in this situation, or you can try blunting the tip of the screwdriver on a grinder (as in the following drawing). By shortening the sharpest part of

All bridge parts can be cleaned with lighter fluid and treated lightly with sewing machine oil or Teflon lube.

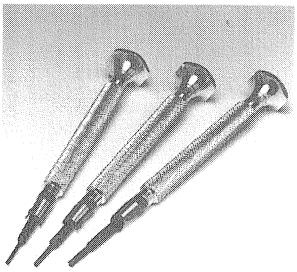


the tip, the screwdriver can then get a grip on what's left of the original slots. Don't fight the hard-caked dirt. Scrape a little out, and then soften the remainder with naphtha. If you're dealing with rust, dab a little Liquid Wrench or WD-40 onto the rusty area. Eventually you'll get the length-adjusting screw to turn, and you can back it out of the saddle.



The height-adjusting screws on Fender-type electrics—in particular the Allen-head type—may be frozen with rust and dirt. It takes a very small, sharp tool to scrape the dirt from the screw's six corner walls. Careful soaking and scraping will, nine times out of ten, finally allow your Allen wrench to slide in properly. Don't try to turn the screw until you're sure the wrench is in far enough that it won't cause stripping!

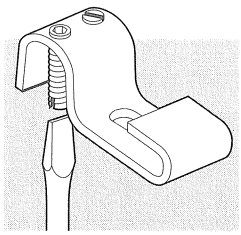
In some cases, even with the wrench well fit into the Allen slot, the screw still won't back out. Try going forward all the way through. If this doesn't work, don't get rough with the part. If the part's free of the guitar, apply a little heat with a propane torch, which causes the parts to expand and contract and often breaks the rusted bond. Do this gently, since overheating could cause premature cracking of the plating, although this has never been a problem for me. *Caution: Be sure that all solvents and explosives are removed from the area, that the part is completely dry, and that there is plenty of fresh air.* If the screw still won't budge, relax and try the following.



Screw extractors are great! For years, I didn't even know they existed—gotta keep my eyes open!

With a small pair of Vise-Grip pliers, grip the very end of the screw from the underside of the saddle. With the saddle clamped or held firmly, remove the part slowly down and through the saddle. If a small bit of thread becomes crushed from the grip, either rethread it with a 4-40 thread-cutting die, or leave it alone, reinstalling it from the bottom up after it's cleaned. This way the crushed thread won't get hung up in the saddle's tapped hole or cause damage to the saddle threads.

If the screw's head is so stripped or rusted that you can't get it to work (and you can't find a replacement, would rather use the vintage part, or have to play in an hour), try this: With the smallest razor-saw blade (.012") or a .010"-.016" nut-slotting file, file a screwdriver slot on the bottom of the screw. Use the new slot to



help remove the screw for cleaning. Then when you replace the screw, reinstall it upside down . This modification switches the Allen head to slot head, with the part now being adjustable with a screwdriver, like with Tele-style bridge saddles. This works great!

Once all the parts are disassembled, submerge them in naphtha. I like to keep all the parts from each saddle together, so they don't get mixed up. Try using a plastic ice cube tray for this, marking the separate compartments *E A D G B E* with an indelible marker. After a good soaking, dry the parts and brush them well with a toothbrush before reassembly. You probably won't even need to oil the parts to get smooth movement after cleaning, but if they're still a little stiff, lubricate the threads with sewing machine oil, Teflon lube, graphite, etc.

Sometimes the effect of a good cleaning causes a height screw to become so clean that it vibrates loose and allows the saddle and string to drop in height, lowering the action (this can happen even if you haven't cleaned the parts). If this is your trouble, adjust the saddle to the proper height and fingerboard radius, and then back each screw out slightly. Use a toothpick to put a drop of glue on the threads right where they enter the saddle itself. Then readjust the screw to the desired position and let it dry. While not actually a bond for metal to metal, the glue will set the threads and stop them from coming loose. A good product for this is the Titebond or Elmer's Carpenter variety of white glue. I've also seen saddles that have a dab of clear silicon bathtub caulk spritzed on the underside around the loose screw. This is a sure-fire method, but it might dampen the tone.

When cleaning parts, don't expect every bit of color or rust to disappear. Metal and plating that have been extensively corroded will never appear new. Just try to get the parts functioning again. Once you've reassembled all the saddles and reinstalled the bridge, put a very light coat on the threads, using any of the lubricants mentioned earlier. Brush the parts off periodically—say, every few months (depending on how much you sweat), or during a change of strings.

Install strings correctly, and they'll stay in tune

Now you can string up—once all the working parts are clean, and before you've adjusted the neck and action. Be sure to use your preferred string gauge. Proper string installation has a lot to do with whether or not you'll be able to keep in tune later. Learning to tune a guitar or electric bass isn't easy—especially if you're starting out. It's hard enough, in fact, that you'll want to know for sure that your guitar isn't working against you and causing tuning hassles that could be avoided. Outside of your ear, training, and playing experience, several factors determine whether your guitar can get in tune and stay there: the shape of the nut and bridge saddle(s), the quality and condition of the tuning keys, and how the strings are installed. Here are several tips that could help you out.

First off, the nut's string slots must not be too deep, and the slots shouldn't pinch the strings: This could cause a string to return flat after a string bend or tremolo dive, and may produce a catchy, "chinking" sound as you tune. If there are notches or grooves in your electric guitar's bridge saddles, be sure they're well-defined (but not too deep), smoothly rounded, and gradually tapered to the saddle's peak. In other words, each end of the string's "speaking length" must have a clean, neat contact point. Adding a tiny drop of lubricant such as Teflube, Vaseline, or powdered graphite at each of these points makes good sense, too.

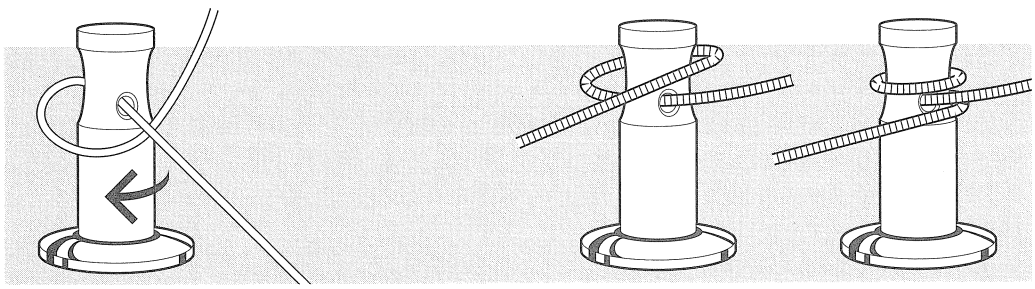
I'm a firm believer in keeping vintage guitars stock, but I also know that replacing the tuning keys may be necessary. Your local music store can help you find exact tuner replacements (some retrofits have the same hole spacings, but better gears and a finer gear ratio). Be sure to save the original parts!

If "vintage" isn't an issue with you, installation of replacement tuners with locking stringposts will eliminate a great deal of tuning hassles. Some stock tuners' mounting holes will show after installing replacements—however, a good repairman can make these almost invisible. In fact, if you're not particularly skilled in guitar work, you'd be wise to have most tuners installed by a pro, unless the tuners are exact retrofits. Locking tuners are available from Schaller, Sperzel, and Gotoh.

With stock, non-locking tuners, how you install the strings may be the key to tuning troubles. With unwound strings (and sometimes a light, wound *G*), I run the string through the slot, pull it toward headstock center, loop it back underneath the string, and then up against the post, thus wrapping it against itself as seen at left, below. This "locking tie" is more difficult with the thicker wound strings. Some people do it, although it can cause kinks, slipping, and string breakage in the heavier wound strings. Try it and see.

For many wound strings, especially the lighter *D*, *A*, and some low-*E* gauges, make the first wrap *over* the string as it comes through the post, and the other wraps *under* as shown. With heavier gauge *A* and low-*E* strings—especially on acoustic sets—just run the string through the post and make all the winds downward. Always wind it tight and neat.

Many tuning woes are psychological. You think you're out of tune when you're not (I know because I suffered from this for years). At some point you must quit worrying about it and have *fun* playing. Once you get your guitar right, have confidence in your ear!



Installing an unwound string

1 Pass the string through the slot in the post.
2 Loop it toward center.
3 Bring the string end back up under the string and begin winding. String is held tightly against post.

For wound strings:

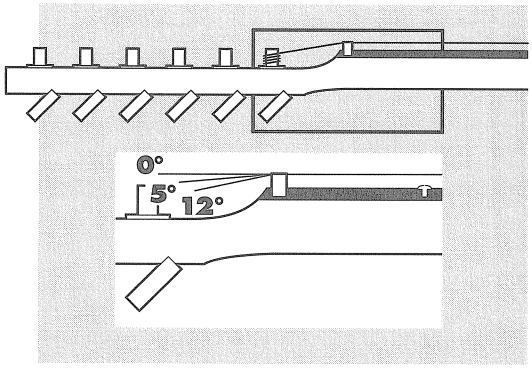
1 First turn wraps the string over itself.
2 Second turn wraps underneath

Some string brands sound better and tune easier than others, but you have to make the choice. Try all the major brands, using your favorite string-gauge set, and expect to take a year or so finding what's best for you.

If you have locking tuners, run the string through the post hole in a natural, straight line. Hold it taut, not tight, while you tighten the string-clamp. Then, in less than a turn, you'll be at pitch. Locking tuners make sense, and I won't be surprised to find them as standard equipment on many guitars before too long.

HOW MUCH STRING SHOULD YOU WIND ON?

For Fender-style guitars (depending on string gauge), wind enough string to keep the angle from the tuner post to the nut somewhere between five and twelve degrees. This angle is less critical for non-tremolo guitars, but too great an angle will cause a string to bind in the nut slot when a tremolo's in use. Too shallow an angle will cause a string to pop out of the nut slot on Fender slab-style necks or other necks with a shallow peghead angle. String "hold-downs," commonly used for the *E*, *B*, *G* and *D*-strings, create the right string /nut angle for you.

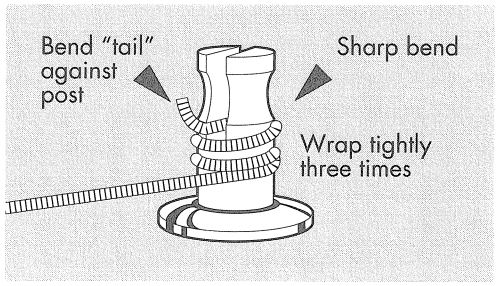


The simplest way of determining how much string to wind on a Fender guitar is to pull the length of string 2 ½ string posts beyond the post you intend to use (that's about 2 ¼" of extra string length), and clip it to length. Then, one method of installing the string is to shove the end of the string down the hole of the slotted "Safeti-Post" vintage-style tuners, and make your string windings downward.

My friend Stan Dixon, the "Wise Master of the Scientific Mystical Guitar Repair Method," is a scientist and a great guitarist from Columbus, Ohio. He never goes out of tune. He taught me another method for stringing up a Strat or Tele with "Safeti-Post" tuners:

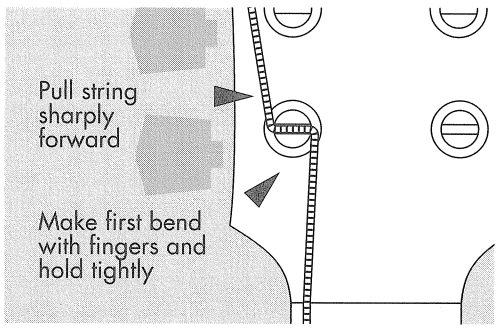
1 Line the tuning key slot parallel with the line of the string.

2 Pull the string tightly around the tuning post and, keeping constant pressure, wrap around three times—going from bottom up.



3 After three full wraps, hold the string against the post with your finger, and with the other hand pull the string tightly through the slot. Finish this with a sharp bend in the opposite direction—making a "D" with a tail at the bottom. Then right at the bend, press the "tail" against the tuning shaft with the flat side of your wire cutters to make it hug the post, and clip it close. Tune to pitch.

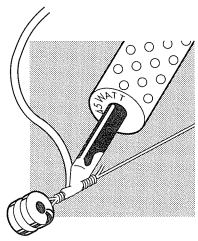
Stan Dixon on traditional tuners (with a hole in the post): "Measure the string two tuning posts longer than the post for which you are stringing. Make a hard 90-degree bend in the string with your fingers. Thread the string through the post hole. Hold the bend of the string tight against the post; with the other hand, pull the short end of the string tightly forward, making another 90-degree bend in the opposite direction from the first. Still holding the string tightly at the first bend, begin winding (making the windings go down the post). The key here is to keep the string tight and all bends at sharp right angles. This lets the edges of the tuning key hole grab the string to keep it from slipping."



MARTIN STRING INSTALLATION SPECIFICATIONS

Acoustic or electric guitars with traditional *angled* pegheads (Martin, Gibson, etc.) require a different number of string winds than bolt-on "slab" necks. You'll find what's right for you after going through a few sets of strings. As an example, here are the Martin factory specifications for string installation: "Bass side strings passed through the string hole with string wound half way around post under longer portion of string, bent backwards over string and wound counter-clockwise two to three wraps around post toward the headplate. Follow this same specification for the treble strings with three to four wraps clockwise around the post."

ONE FINAL TRICK...



This is a bit of work if you change strings often (and a labor of love if your repairman does it for you). Using a hot soldering iron with 60/40 resin-core solder, tin each string's wrapping at the ball end. This keeps it from slipping or tightening like a hangman's noose at the tailpiece. "Tinning" is the process of lightly pre-coating an electrical lead with solder and letting it cool before making the final solder joint. Well-tinned string wraps should shine like silver and never be gloppy or heavy with solder. The use of a 40–45-watt iron will enable you to get on and off the string in a flash, without overheating it. The low-wattage (15–25-watt) hardware store soldering irons will not work as well.

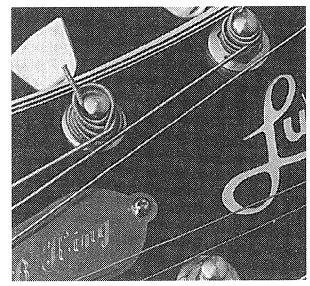
Note: Don't do any soldering on, over, or near your guitar! Molten solder drips, splatters, and spits—and can make a beautiful finish look horrible. It's not good for your eyes, either, so wear safety glasses!

Neck evaluation and truss rod adjustment

Neck adjusting is simple—you tighten or loosen a nut. Knowing when it's adjusted correctly is the trick. The methods shown here are extremely important and will be used again and again in the remainder of the book—especially in the chapter on fretting.

What follows is an in-depth look at evaluating a neck using straightedges: first I'll show you how to "read" and understand different neck configurations, and then I'll describe the many types of straightedges often used for the job. Finally, we'll go through a typical adjustment using a bass guitar as an example, since they're often the most difficult to adjust.

When customers arrive at my shop wanting a guitar neck adjustment, it's usually for one of the following reasons: the strings buzz on the frets, the "action" is too high (that is, the strings are too far from the fingerboard), or the strings buzz on the upper frets along the "tongue"—the part of the neck that overlaps the body. Sometimes the notes aren't playing clean, or the instrument has intonation problems despite having a perfectly calibrated bridge. All of these are symptoms of a neck that needs adjustment. With an understanding of the basics of neck rod adjustment, action evaluation, and fingerboard straightness and relief, you're on your way to getting your instrument to play its best. Always use your favorite gauge of strings, tuned to pitch, for these adjustments.

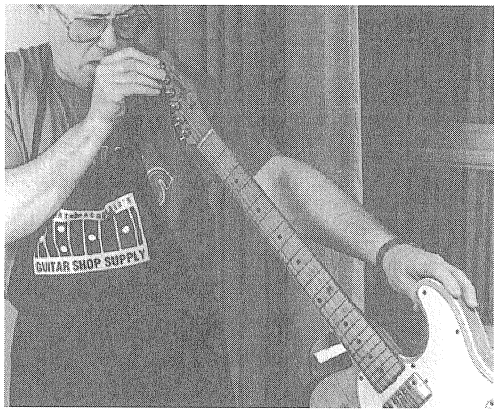


When I interviewed B.B. King for *Guitar Player*, I found that he installs the *entire string*—winding up all the slack onto each post. It seems like a lot of work, and I would never have thought of it, but Mr. King seldom goes out of tune—and he "invented" string-bending!

SIGHTING THE NECK AND ADJUSTING THE TRUSS ROD IN THE PLAYING POSITION

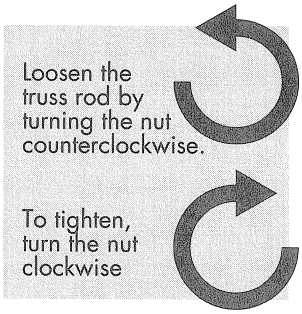
First, "sight" the neck. Place your nose close to the headstock and look along the fingerboard edge from the nut toward the body. You're looking for straightness, humps, up-bow (often called forward-bow), back-bow, and high frets. Up-bow pushes the surface of the fretboard *away* from the strings, while backbow pulls the fretboard *toward* the strings. Check both the bass and treble sides, since they may look different; I wear safety glasses in case

Some necks say "steel-reinforced," but have no adjustment. You can often straighten these by using heat to soften the glue joint before bending the neck into the desired position.



a string breaks. Neck sighting should be done in the actual "playing position," with the guitar on its side. Also in the playing position, double-check what your eye tells you with a good straightedge. The best entry level, inexpensive straightedges are a 12" steel "combination" square (the handle slides off, leaving only the blade) and a "rafter square," which has two edges—a 16" and a 24". These three lengths are adequate for most neck evaluations on guitar or bass. Read on and you'll learn where, and why, to use each length.

Most necks are adjustable by tightening or loosening a truss rod nut. These neck rod adjusting nuts are located at the end of the headstock or recessed into the body at the very end of the fingerboard. Some acoustic guitars are adjustable under the fingerboard, accessible through the soundhole. Find the adjusting nut and choose the proper tool for turning it; this will usually be an Allen wrench, socket/nut driver, or a screwdriver.



Tightening (turning clockwise) straightens an up-bow and removes relief. Loosening counterclockwise allows some back-bowed necks that warp *away* from the strings to pull straight, or into relief (see illustration). An old rule for tightening a nut that sounds silly but works is: "righty-tighty, lefty-loosey."

On a workbench or tabletop, set the guitar (strung to pitch) on its side in the playing position with the neck unsupported. You'll need backlighting for the straightedge test (experiment to find the best placement), and I use white shelf paper on the benchtop—it makes an excellent visual background. Set the straightedge on the fingerboard between the third and fourth strings. It should run from the 1st fret to the 17th, covering most of the fingerboard. Hold the straightedge with one hand and, while adjusting the truss rod with the other, watch the light under the straightedge.

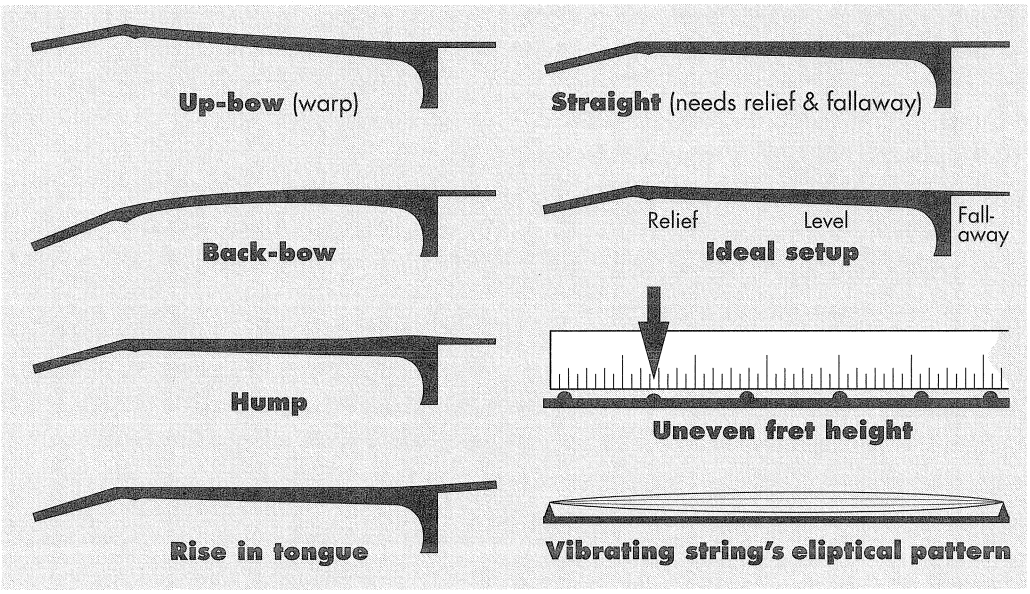
Don't despair if your straightedge isn't long enough. Any string becomes an excellent straightedge when depressed between two frets (in this case the 1st and 17th). In fact, at the Fender company, they always install a capo at the first fret, for adjusting neck straightness and relief or for setting the string height. The capo eliminates the nut height as a factor and frees up one hand for measuring relief and adjusting the truss rod. You can read more about this in the "ten-step" method for setting up a Strat in the "Strat Setup" section.

If the straightedge "rocks" on the fingerboard due to back-bowing, loosen the nut counterclockwise, watching for the fingerboard to come into level contact with the rule. If the strings are pulling the neck up in a slight curve, slowly tighten the nut clockwise until the rule rests flat on (hopefully) all the frets. If you loosen it now, the curve or bow will return to the fingerboard. This slight, controlled bow is called "relief." Remember how relief looks. When tightening a nut, it's best to first loosen it completely, then slowly tighten until it begins to grab and feel snug without exerting any real pressure. From this point, a quarter- to a half-turn usually straightens a neck against string pull. It would be rare to take a full turn. A squeak is a telltale sign that you are at the limit—stop there! Overtightening can strip the nut, neck rod threads, or both. As you'll see shortly, it's always a good idea to clean and lubricate the threads of the truss rod and nut.

Caution: Some necks adjust more easily than others. If you sense trouble or have doubts, find a trained person and pay the small cost for an adjustment. Ask if you might look on. A trained hand knows immediately if the rod is working properly.

UNDERSTANDING RELIEF

Relief is often the key to low string height, few buzzes, and comfortable action. If you pluck a string, especially a wound one, the greatest movement occurs toward the center of



the string length. The string moves in a long, elliptical pattern. By loosening the rod, the fingerboard gains relief, allowing a greater clearance for the vibrating portion of the string between the fretted note and the bridge. Relief can also eliminate buzzing on open strings near the nut and the first few frets, where the strings are lowest. Different amounts of relief are necessary depending upon a player's style and preferred string gauge, differing scale-lengths, and the height of the action. Experiment with adjusting relief in and out of the neck. Be sure to play the guitar at each stage to see the effect.

Expect that you may have to raise or lower the bridge saddle height after a neck adjustment. In fact, a pro will adjust the neck and string height simultaneously—tighten or loosen the rod, raise or lower the bridge—back and forth until the action is set. We set the string height separately in the next section of this chapter (later you'll use all the techniques together in a smooth, flowing operation with experience as your guide).

All instruments don't need relief—in fact I always try to get an instrument to play with a perfectly straight neck first, and only add enough relief to eliminate unmanageable buzzing. Straight necks have lower, faster action—necks with relief play a little stiffer and mushier toward the center of the neck. Necks with too much relief and low action may buzz in the upper register. It's important to understand how relief relates first to the fretboard as a whole and secondly to the upper part of the fretboard, which I call the "flatten-out" area.

Relief is measured by inserting a feeler gauge in the maximum gap between the top of the frets and the bottom of a straightedge. Measure at the approximate halfway point of the neck—not the fretboard—between the nut and where the neck joins the body (normally between the 6th and 9th frets). Factory specifications for relief are listed elsewhere in this book, but as a rule relief will measure as follows: guitars—from .004" to .012"; basses—from .008" to .018".

For guitar, it's best to check relief with an 18" straightedge—or one that will reach at least to the 15th or 17th fret (covering most of the fretboard). For bass you need a 24" edge. Study the illustration to understand how a "perfect" neck looks in both the straight and the relieved, configurations. Relief should gradually disappear as the straightedge is slid further up the neck. You can demonstrate this best by clamping a somewhat flexible but dead flat board to a tabletop, laying a straightedge on it, and pulling up on one end. You should see a curve that gradually disappears as the straightedge is slid further up the "neck." There should never be a hump or a rise at the end! It's OK if the last portion falls slightly away from the straightedge. This slight "fallaway" in the last few frets would *guarantee* no buzzing in the

upper register, but it's not a must—either dead flatness, or else fallaway, is correct. Whenever the upper register of the fretboard (called the "tongue," or fretboard extension) rises instead of being flat or falling away, you have a symptom called "rising tongue" (covered in the fretting section).

So relief really needs to be measured *first* with the long straightedge to see the whole board, and then *double-checked* with a shorter edge to view the flatten-out area from the 7th, 8th, or 9th fret up. If the flat area shows a gap where it should read flat, then you really can't measure the whole board's true relief because of this "secondary relief," caused by the rise or hump. Many necks have this problem, and the only solutions are:

- playing with some buzz on upper frets
- raising the string height
- filing the rise out of the frets
- removing the frets, flattening the wood properly, and replacing at least the last 6 frets (a partial fret-job: refer to the Fretting chapter).

When you have symptoms such as humps and rises, it's far easier to isolate them using a notched straightedge. Several of my favorite straightedges are notched to fit *over* the frets, allowing me to read the fretboard instead of the frets (which may be worn in one area and not another, or poorly seated, and won't give a true picture of fingerboard flatness). I've named this technique the "MacRostie Method" after my good friend Don MacRostie, who invented the notched straightedge and presented me with my first set.

Don MacRostie using the notched straightedge

After adjusting a bit of relief into your guitar's neck, rest a normal (unnotched) straightedge on the board and slide it one fret at a time toward the body. The edge should drop from fret to fret as it moves, indicating that each fret is slightly higher than the one following it. As you slide the rule, it should quit dropping and level out between the 7th and 10th frets, and remain flat the rest of the way. As we said earlier, it's OK when the frets from the 15th on up fall slightly away from the rule. I call this "fall away," and it ensures clean notes in the upper register.

Note: When trying to view the flat area with a too-long straightedge, you may find that it runs into the pickups and/or bridge before you can slide it onto the area you're after. Yet another reason you need straightedges of different lengths.

STRAIGHTEDGES: A PROFESSIONAL'S TOOLS

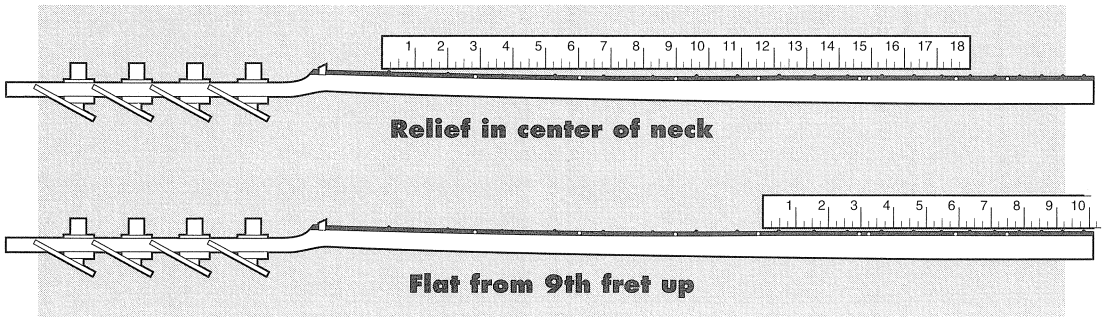
Inexpensive hardware-store straightedges can only give you a ballpark reading of a neck. Professional repair shops invest hundreds of dollars in *precision-ground* straightedges of different lengths. At the entry level, you can get by with the straightedge and rafter square mentioned above (for guitar and bass), but when you really want to know what's happening, check into professional straightedges. When I can find them, I prefer straightedges with one beveled edge since they give more accurate readings. High quality precision-ground straightedges have a thickness proportional to their length—the longer, the thicker—to keep them from being "sprung" from end to end (not straight along their flat side) because of flimsiness. An edge this thick, however, won't give a reading to suit me—so all of my longer straightedges must be beveled. Beveled or not, I use the following lengths:

- 2"—Fret rocker.
- 3"—Fret rocker. These first two lengths are for setting across any three frets (on guitar or bass) to "rock"—looking for high spots. These straightedges are 1½" wide. When set on end, they act as rockers for close frets.
- 8"—Reading the area (on guitar) from 9th fret to fingerboard end.
- 12"—General flatness, guitar or bass (also good from 9th fret to fingerboard end on bass).
- 15"—Same as above (slight differences).
- 18"—To look for relief/check flatness on guitar or bass.
- 24"—Check relief and flatness on bass.

Notched, beveled one edge:

- 18"—Notched short scale (24¾"/24.9").
- 18"—Notched long scale (25½"/25.4").
- 24"—Notched standard scale bass (34").

Of the above three notched straightedges, I took one of each length and cut it at the 9th fret. With these half-length notched edges I can read either the upper or lower portion of the fretboard independently.



A TYPICAL NECK ADJUSTMENT SCENARIO

Neck adjustment problems common to all acoustic or electric guitars and basses are most exaggerated on the Fender electric bass because of its long, slim neck. So the electric bass makes an excellent teaching example for neck adjustments as a whole. The techniques shown here apply to all guitars and to every scale length—basses just tend to need a little more help than guitars. I borrowed this section on bass setup from the Summer '90 "Red Hot Equipment" issue of *Bass Player* magazine—because it's the most thorough article I've written on truss rod adjustment (for our purposes, the word "instrument" or "guitar" has been substituted for the word "bass"). Here I'm reprinting most of the article even though it repeats some of the steps just mentioned.

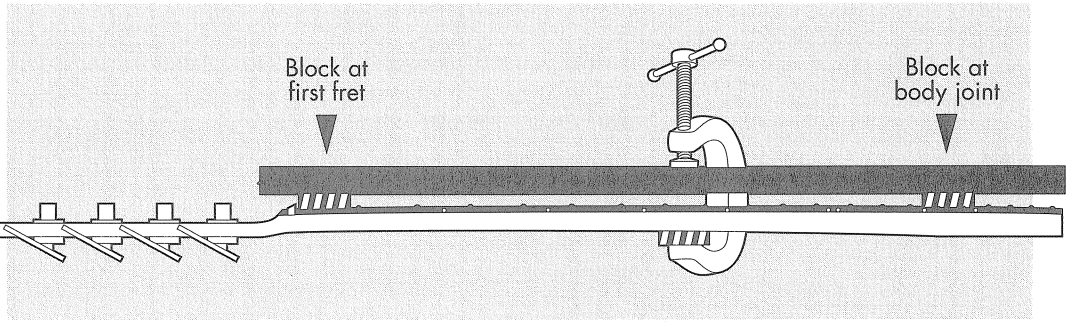
Guitar necks can be straight, back-bowed (convex fingerboard), up-bowed (concave fingerboard), or somewhere in between. The straighter the neck, the closer the strings can be to the fingerboard for easy action—but you must play with a light touch close to the bridge to avoid buzz or fret rattle. Conversely, if you play close to the neck and dig in, you'll need some relief to avoid buzzes.

A "perfect neck" is one that, under string tension, adjusts straight for low action and easy fret dressing, has a slight back-bow when desired to counteract heavy strings, and loosens from straightness into controlled relief. A properly relieved neck (see illustration above) shows a gradual up-bow going from around the 9th fret toward the nut, but remains straight from the 9th to the last fret. The overall curve in the fret tops between the 1st fret and the body joint mimics the string's long elliptical pattern as it vibrates when plucked. This eliminates a lot of fret buzz.

Sighting a neck is the simplest way of checking if it's straight, back-bowed, up-bowed, or in controlled relief. Hold your guitar on its side in the playing position to get a true reading from the neck. Support the body, not the neck. Sight from the nut toward the body, and if you have trouble looking along the fret tops, sight along the glue joint between the fingerboard and the wood of the neck, using the line as a straightedge. You can also check by holding down a string at the 1st fret and at the body joint, since a tight string is a good straightedge. Or, to get a truly accurate reading, use a precision-ground straightedge for comparison. This sighting of the neck determines if, and how, any adjustments should be made.

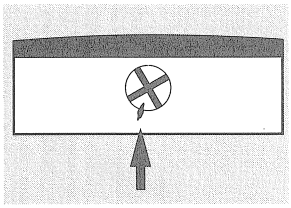
Most necks are adjustable by tightening or loosening a truss rod nut. These neck rod adjusting nuts are located at the end of the headstock or recessed into the body at the very end of the fingerboard. Some acoustic guitars are adjustable under the fingerboard, with the adjusting nut accessible through the soundhole. Find it and choose the proper tool for turning it; this will usually be an Allen wrench, socket/nut driver, or screwdriver.

Tightening—turning clockwise—straightens an up-bow and removes relief. Loosening counter-clockwise allows some back-bowed necks that warp away from the strings to pull straight, or into relief. An old rule for tightening a nut that sounds silly but works is: "righty-tighty, lefty-loosey." Keep these few thoughts in mind when making any adjustments, and follow these steps in order:



■ The adjustment nut on many bolt-on, slab-style necks is at the body end. It's usually accessible only after loosening the strings and removing the neck.

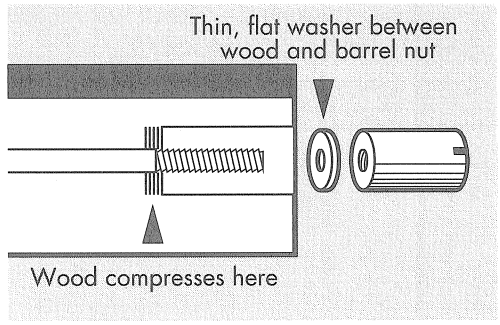
■ Always *loosen* the truss rod nut first, since it may already be as tight as it goes. You'd hate to break it before even getting started. In fact, remove it completely and brush or blow any dirt from the threads of both the rod and the nut. Follow with a *tiny* dab of lubricant on the threads inside the truss rod nut (use Tri-Flow, Vaseline, Magik Guitar Lube, or oil), being careful not to get any on the bare wood. Lubricating the threads makes for a smoother adjustment, especially on older instruments.



■ Without putting tension on it, reinstall the nut until it's just snug. Then make a small pencil or pen mark on both the nut and the neck. When the marks line up, that's your snug starting point—a nice reference when making adjustments.

■ One half-turn on a truss rod nut is a lot. Once a nut reaches snugness, tighten it one eighth- to one quarter-turn and then check your progress. Expect to remove and install the neck several times during this process.

■ The effect of a rod adjustment can take days or weeks to be complete. You may adjust a neck perfectly, only to find a day later that the neck has kept moving from the rod's tension—becoming *too* straight or even back-bowed. Don't panic if this happens; simply readjust it.



■ If the truss rod barrel nut is extremely tight on the rod or recessed far into the hole, watch out! It was probably overtightened by a previous owner or amateur "repairman." Some ill-informed people really crank those truss rods, which is a great way to break them, causing your bass neck to become permanently non-adjustable. Overtightening can also cause the wood to compress without straightening the up-bow. In this case, follow the removal, cleaning, and lubrication steps above, and then add one or two thin washers before threading on the nut. Often this will give the nut a new grip on life and allow the rod to adjust further.

■ With a stubborn neck, sometimes it's best to loosen the rod completely, clamp the neck into straightness (or even a back-bow as seen above), and *then* tighten the truss rod nut. This method generally works when all else fails.

Setting intonation

Repairmen are often asked: What is the reason for the different saddle positions on tunable bridges? Why are some bridge saddles closer to—or further from—the nut? These questions bring up the subject of string-length compensation (most players refer to this as "setting the intonation"). This is an essential part of setting up both acoustics and electrics.

UNDERSTANDING STRING LENGTH "COMPENSATION"

To begin with, accept the fact that fretted string instruments are accurate to a point, but they are not perfect and never will be. With its fixed frets, the guitar is known as an even-tempered instrument. The fret scales are compromised so that a guitar plays closely in tune in all keys but, alas, never perfectly in any. Many players can hear the out-of-tune notes in the even-tempered scale, and it drives them (and their repairmen) crazy.

At best, proper intonation is a compromise among many factors, and at a certain point guitarists must accept some degree of out-of-tuneness or give up the guitar. Too often the repairman doing the setup is blamed for not getting a guitar "perfect," and that's not fair.

Understanding the compensation factors that determine the need for intonation adjustment is tricky, and here experience is the best teacher. Your repairman is doing a lot more than turning a couple of screws. He's checking to be sure that all other important adjustments—such as truss rod, action height, fret dressing, nut and bridge saddle shape, string gauge, etc.—have been made before setting the intonation. That's important!

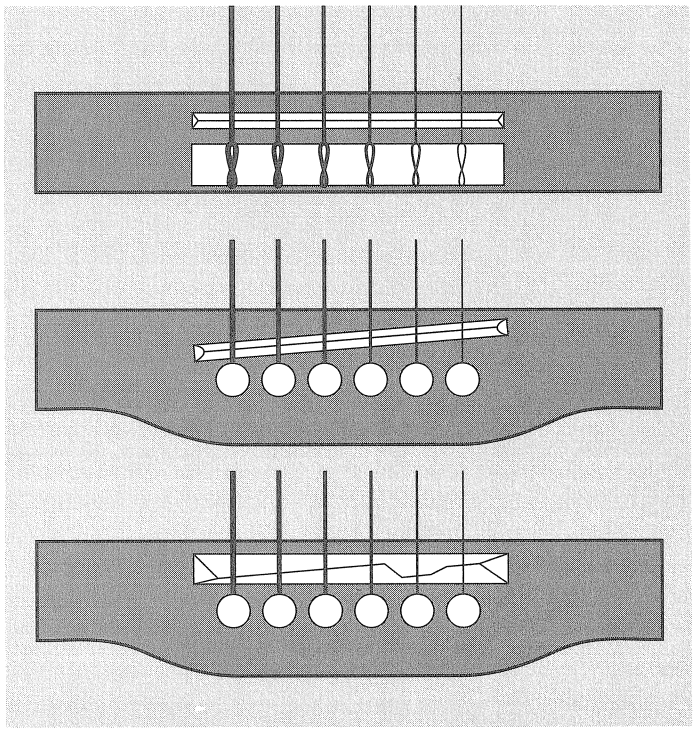
Many factors contribute to the need for compensation, and most are confusing to the layman (and occasionally to repairmen, as well!). I like things simple, so here are some basic facts regarding string-length compensation as I understand it. Any combination of these factors can cause a need for compensation, so try to look at the whole picture.

When we discuss a string length, or scale, we're referring to the distance from the nut to the center of the saddle, measured in a direct line down the center of the fingerboard and body. A Strat, for example, has a scale length of 25½". But the bridge saddles may actually measure as much as ⅛" to 3/16" more than that, depending on string height, string gauge, etc. This addition to the string's length at the saddle is known as compensation. A basic understanding of compensation is necessary before the guitar's intonation can be properly set. Compensation is the adjustment that changes the mathematical (measured) scale of a guitar by altering the string length—almost always at the bridge saddle. This procedure sets the intonation, and is crucial for proper noting. Compensation has been accounted for at the factory on most non-adjustable acoustic guitars and is seldom a serious problem. Most acoustic guitars with problems suffer from *sharpness* and need to be compensated by adding to the string length. Occasionally, though, flatness caused by overcompensation is found on acoustics on which the bridge has been installed out of position.

Pressing a string down into the fingerboard too hard can cause a sharping problem, especially with tall frets. This can be corrected by changing your playing style.

Although acoustic guitars are compensated at the factory, do not expect them to play in perfect tune, intonation-wise. This job must be completed after the sale to suit the individual player's needs, and it's governed by the many factors listed here.

When setting intonation, we try to get a string to play the same note when fretted at the 12th fret as when played open, only an octave higher. In theory, the distance from the nut to the 12th fret is the same as the 12th fret to the saddle, since the 12th fret is the octave and halfway point of the scale (scale length equals the measurement from the nut to the 12th fret, times two). In practice, the string length must be increased to offset the sharpness that results when the string is pressed down during playing (remember—the mathematical distance of the scale runs in a straight line from the front edge of the nut to the saddle's center). The string, however, runs up and away at an angle to this line. When pressed to the frets during playing, it becomes stretched, which causes it to



go sharp. This is the basic, and the most easily understood, explanation of the need for compensation. Add it to the factors below, and you'll see why the seemingly simple job of setting the intonation can cause you to tear your hair out before you finally take the guitar to a repair shop, so they can tear their hair out!

STRING-LENGTH COMPENSATION

The closer the strings are to the fingerboard, the less compensation is needed, since the strings go sharp less when pressed. However, guitars with lighter strings generally need more compensation than heavier ones, since as string tension decreases (going from heavier-gauge strings to lighter), the compensation need increases. Therefore, the lighter the strings and the lower the tension, the more need for compensation. So, perhaps one cancels out the other. Confusing, but you can prove it for yourself by trying this test:

Using an electronic tuner, check your guitar's intonation on the low-*E* string at concert pitch. Retune the string to *D*. It will intonate sharper, which indicates the need for more compensation, or added string length. That's why the modern electric player, who uses .010 strings or lighter, often searches far and wide to find a repairman to set the intonation.

Wound strings need more compensation than plain ones. Because of their extra weight and slower, low-pitched vibrations, wound strings need more clearance from the fingerboard to avoid buzzing. The extra clearance is gained by raising the string height from the fingerboard for wound strings. This increase in height causes the strings to go sharp more than the unwounds when depressed. This is why bridge saddles slant toward the bass side on steel-string acoustics or electrics.

I like the term "speaking length" of a string. Franz Jahnel's comprehensive *Manual of Guitar Technology* refers to the mathematical string length as the "true" length (the measured distance from nut to bridge saddle), and the actual vibrating length as the "playing," or speaking, length. A string, especially a wound one, doesn't actually start vibrating, or speaking, until it gets a certain distance from the nut or the saddle. So, part of the string's "length" (in terms of sound) is always lost—another reason for compensation.

Notice that classical guitars have saddles with no slant (top illustration above). Why? The wound strings have a stranded core rather than a solid one, and sharp out at a rate similar to that of the solid nylon treble strings. Classical strings have a more even tension across the fingerboard than steel strings. Therefore, they require close to the same amount of compensation per string, and in general are more uniformly spaced from the fingerboard in terms of height. You may find saddles that have been slightly filed off-center (compensated) under the *B* and *G* strings on some classicals.

Instruments with longer scales need less compensation than shorter-scaled ones, because the longer string must be tighter to reach the same pitch. Thus the longer string is less apt to be sharp when fretted and needs less compensation (the higher the tension, the less a string goes sharp). The two most common scales are long and short. Long scales are 25½" or thereabouts (these include Strats, all their clones, and many Gibsons; Martin uses a 25.4" and Guild a 25⅜", but we lump them all together as long scale); short scales are 24¾" or thereabouts (Gibson Les Pauls, ES-335s, smaller Martins at 24.9", etc.). Classical guitars have long scales. There are many other scales, but only a few really common ones: a "medium" 25" scale is used on Danelectros and PRS guitars (I really love this scale); a "Three-Quarter Scale" (23") is used on the Gibson Byrdland and the ES-350-T; and Fender's Duo-Sonics, Mustangs and Musicmasters use 24" or 22½" scales.

SETTING ELECTRIC (ADJUSTABLE) BRIDGE INTONATION

Setting the intonation on guitars with adjustable bridges (which even some acoustics have) is simple. All that's needed is a small Phillips or flat-bladed screwdriver or an Allen wrench. If a string sounds sharp at the 12th fret, move the saddle back—away from the nut—to increase the string length. If a string sounds flat at the 12th fret, move the saddle forward—toward the nut.

THE "BASIC RULE" FOR SETTING INTONATION

- If the string notes sharp, move the saddle back—increasing the string length.
- If the string notes flat, move the saddle forward—shortening the string length.

SETTING ACOUSTIC (NON-ADJUSTABLE) BRIDGE SADDLE INTONATION

Acoustic guitars tend to shrink over the years because they're made of wood. Add to this the effect of the string's pressure pulling the nut and saddle toward each other, and you lose a bit of string length—measured in thousandths of an inch, perhaps, but it all adds up. Even solidbody electrics suffer from string tension compression on the neck and lose some string length over the years.

Differences in a string's gauge, quality, and physical makeup drastically affect intonation. As a string's cross section (diameter) increases, so does the need for compensation: hence the saddle slant toward the bass side on steel-string guitars. A string's elasticity, or ability to return to its original position after being deflected, is also a compensation factor, and stiffer strings go sharp more when depressed. You'll have to try many brands and gauges before settling on the right strings for you. The sad thing is that by the time you find the set you like, your playing style may have evolved to a new level, requiring that you start all over again! (*Frets* magazine published in-depth string articles in the Nov. '84 and Aug. '87 issues; check your library for back issues.)

The standard factory-installed slant saddle on acoustic guitars is usually sufficient compensation to please most players. The saddle slants approximately ⅛" in a 3" length, toward the bass side (middle drawing on facing page). If the intonation doesn't please you, ask your repairperson about a compensated saddle (where a wider saddle blank is inserted and then filed to staggered peaks under the different strings, as in the bottom drawing at left). If you're interested in compensating your own saddle, study the books listed at the end of this section—in particular those written by Don Teeter.

All of these are factors when it comes to setting your guitar's intonation by compensating. Their interrelation is complex, and the slightest change in any factor (especially string height) can throw the whole deal out of whack. Be sure that the important adjustments described earlier have been made before setting the intonation. An electronic tuner is a big help, also. The following approximate compensation is usually added to the scale length of any guitar:

- Most electrics and steel-string acoustics—from ⅛" to 3⁄16".
- Classical saddles—from 1⁄16" to 7⁄64".
- Electric bass—from ⅛" to ¼".

I hope this information helps you understand how even a top-quality guitar can play out of tune, and why it can be so tough to get it right. Support your local repairman!

You'll find that an electronic tuner is a big help when you're setting the intonation.

Special thanks to William Cumpiano and Dick Boak from Martin Guitar's Woodworker's Dream—two expert luthiers who were very helpful with technical information. Woodworker's Dream has a great selection of rare hardwoods and guitar parts, and their catalog is a must for aspiring luthiers.

More information on this subject may be found in Don Teeter's *The Acoustic Guitar, Vols. 1 and 2,* Hideo Kamimoto's *Complete Guitar Repair,* Franz Jahnel's *Manual of Guitar Technology,* the Guild of American Luthiers' *Data Sheets,* and *Guitar Making: Tradition and Technology,* by William Cumpiano and Jon Natelson. A list of suppliers for these books, and more, is given at the end of this book.

That's it for cleaning and minor adjustments for a guitar or bass. I hope your axe is playing as good as mine! If not, go on to the setup chapter.

What is a setup?

OK. Your guitar is clean, lubricated, and strung to pitch. You can set the intonation, and you understand neck adjustment. Now, at the setup stage, you'll adjust the overall action—working with neck, bridge, and nut adjustments. For most electric guitars, the action height is adjusted by raising or lowering the entire bridge if it's a Gibson Tune-O-Matic style, or by adjusting the individual bridge saddles of Fender-style bridges. If you need to adjust the action of an acoustic guitar at this stage by raising or lowering its typically non-adjustable "bone" saddle, you'd have to reshape or replace the saddle entirely (this is covered in the Acoustic Adjustments chapter). Some other problems which might temporarily stop you at this stage are:

- Strings buzz open. The nut needs to be raised (shimmed) or replaced.
- Buzzing frets which need to be replaced or dressed.
- Inoperable bridge saddles on acoustics or electrics which will require re-fitting or replacement.
- An acoustic bridge that needs to be reglued.
- A bridge that can't be raised or lowered.

If you have such symptoms, you'll have to solve the problem before going further. For the novice, even replacing a bridge saddle on a Tune-O-Matic can be a problem, so it's OK to jump ahead to the chapters on Electric or Acoustic adjustments to find the solution you need. But if you *do* jump ahead, don't *stay* there—come back and finish this section after you solve the problem that held you up.

Those of you with fully functional guitars should stay right here. Remember that we're either setting up a used guitar (which except for needing a little cleanup and adjustment was actually in pretty good shape), or else we're fine-tuning a brand-new axe which has gotten slightly out of factory adjustment. It's fair to assume that a large number of the better instruments will fall into this "healthy" guitar category: i.e., an instrument that plays well after a good cleaning, restringing, neck

adjustment, a simple raising or lowering of the action and setting of the intonation.

The object of adjusting the string height is to get the action to feel comfortable with the neck adjustments you've just made. Or, as I mentioned earlier, you may need to adjust the action *while* you adjust the neck. Besides, it's pointless to get on with setting the intonation until the action is where you want it. If the strings are either too high or too low, any fine-tuning of the intonation goes right out the window if you have to readjust the string height afterward.

In a shop situation, the technician does a setup by thinking of neck, bridge, fret, and nut adjustments as a whole. Experience dictates which jobs need to be done, and in what order. For example, a professional wouldn't make a neck adjustment, restring, fine-tune the nut, set the action and intonation, and then go *back* to dress the frets. If a professional is in the middle of a setup and discovers a bad nut, he or she will stop, make the nut, and then catch up to the leaving off point. Some of these side-trips involve repair work, such as shimming or replacing the nut, replacing an acoustic saddle, and replacing or dressing frets. These jobs are covered in appropriate chapters. So the remainder of this Setup section assumes that:

- The guitar is clean and strung to pitch.
- The frets are level and OK.
- The neck is adjusted to what you *think* is right (the following setups may change that slightly).
- The nut is not in need of replacement (it may be too high—lowering that can be part of setup, but replacing it is not).
- All bridge parts are functional.

A basic way to set action, and the method I used for years when I didn't *have* any factory specs, is to just lower the bridge until the strings buzz, and then gradually raise the bridge until the buzzing either stops or is no longer bothersome. In other words, set your action "by eye" until it feels good. Develop your own opinion: the factory specs only give you a good place to start from, or return to, when setting up a guitar.

THE BIG THREE

Setting action is a subtle task, and the different manufacturers each have their own specifications for a correct factory setup (there are so many guitar manufacturers and individual builders that I'd never attempt to list the factory specs of even a tenth of them). I use the "Big Three": Martin, Gibson, and Fender, as setup examples for steel-string guitars, acoustic or electric, throughout this book. Excepting nylon stringed classical guitars, most contemporary guitarmakers have followed the example set by the "Big Three." (Guitars equipped with Floyd Rose, Schaller, Kahler and other locking-nut, fulcrum tremolo bridges follow many of the same setup procedures shown here. For specifics, refer to the tremolo section.)

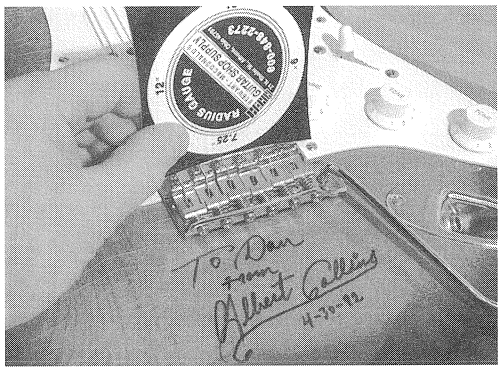
A factory setup is "middle of the road" enough to satisfy most players and to remain in basic adjustment after being shipped around the world to many different climates. Changes in climate—especially humidity—can cause an otherwise straight neck to become either back- or up-bowed—that's one reason why truss rods are installed.

FRETBOARD AND BRIDGE SADDLE RADIUS

These excerpts from a *Guitar Player* column explain how the fretboard and bridge saddle radius are related:

Before taking our vows, we repairmen have learned from experience that a certain amount of buzzing comes with the job—metal strings on metal frets buzz a little. Proper neck adjustment and fret-leveling removes 90% of most buzzes. The remaining 10% should be accepted as normal and will play themselves out in time. Of course, any buzz can be eliminated by raising the action high enough, but this won't satisfy most players.

One cause of string buzz that's often overlooked, however, is the improper matching of the shape of the bridge saddle's curve to that of the fingerboard. Most steel-string guitars have curved (arched, or radiused) fingerboards, although the amount of radius differs among manufacturers (Martin and Gretsch seem to have the flattest fingerboards). If the bridge saddle curve is significantly flatter than the fingerboard's radius, the middle strings will be



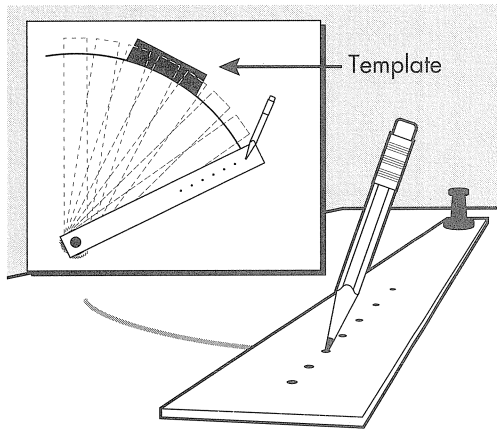
closer to the frets than the outer ones, causing buzzes. Correcting this poor saddle adjustment often immediately eliminates buzz, as well as the need for fret-leveling. You'll also find that a proper bridge setup makes for a more comfortable axe, especially when you play chords. Here's how to make and use a simple tool—a radius gauge for setting your bridge saddles.

MAKING A RADIUS GAUGE

It's not much trouble to make a radius gauge, so if you're unsure about which size you need, make them all and see which fits. The most popular fingerboard radii are: 7¼"—vintage Fender; 9½"—some current Fenders; 10"—Kramer and many replacement necks; 12"—Gibson; and the 16" to 20" range for Jackson, Martin, Gretsch, and others with a flatter fingerboard. I made my radius gauges from Plexiglas, so that they'd last through years of use. Cardboard or thin wood work fine if you're only occasionally setting up your own guitar.

Start with a piece of stiff cardboard or thin wood about 24" long and 1" wide. Draw a center line on this piece and make a mark 1" in from one end—this is your starting point, axis, or center. From your axis mark, measure the correct distance for the radius you want (7¼", 9½", 12", etc.), and make marks accordingly. Next, lay the marked-out strip on a large piece of stiff posterboard (smooth-faced cardboard) and press a sharp pin through the center, pinning the strip to the posterboard below. Now if you poke a second pin through any of the measured "radius" marks, you can scribe the different radii onto the posterboard (above).

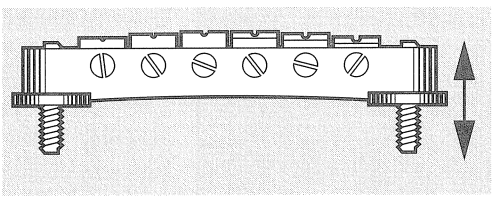
The gauges should be 4" in length—or long enough to lay out an acoustic or electric guitar saddle. Cut out the templates with a sharp blade in the shape illustrated by the shaded line in the

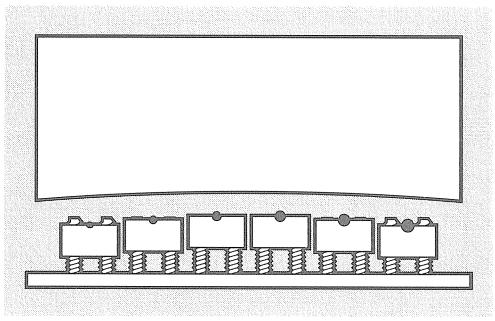


If making a radius gauge is too much trouble, try Stewart-MacDonald's inexpensive two-piece set. Each has four radii: 7¼", 9½", 10", 12", 14", 16", 18", and 20".

drawing. Thin wood or cardboard can be hard to sand or shape, so make your first cut accurate. If you do need to custom-fit your gauge to the fingerboard, reinforce the wood or cardboard gauge by saturating it with Hot Stuff original formula super glue. Once it's dried, you'll find that you can carve, file, or sand the thin material much more effectively. *Note: Always wear safety glasses when working with Hot Stuff or any super glue!*

Use the gauge first to measure the fingerboard radius with the strings removed, and then sight across your guitar's bridge saddles, lengthwise from *E* to *E*. On most electrics or acoustics, you should see a gentle rise through the *A* and *D* strings, going back down through the *G* and *B* to the *E*. This curve should approximate the fingerboard's curve. Some guitars have a curve built into the bridge (as in Gibson Tune-O-Matic and "Nashville" bridges), rather than using up/down adjustable saddles. With this Gibson type of bridge, variations in the saddle radius can be controlled by the depth of the saddle slot filed into each bridge saddle insert (see the section on Gibson Tune-O-Matics in the next chapter), while *overall* string height is tailored by raising or lowering the bridge's treble and bass sides, by adjusting the thumbscrews on either end. Most Fenders and many of their clones, on the other hand, have saddles that easily move up or down. Take advantage of the adjustment to set your strings exactly to the fingerboard.





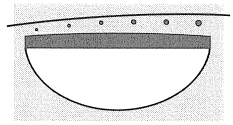
SETTING A FENDER ADJUSTABLE BRIDGE RADIUS

Adjust the outside *E* strings to the action height that you like by using the 6" steel rule to measure the gap between the bottom of the strings and the top of the 17th fret (see the factory setup that follows). Now place your radius gauge on the two outer *E* strings just in front of the bridge saddles, and raise or lower the four middle strings (*A D G B*) until they, too, just touch the gauge—it's really simple. Your bridge saddle curve will now match the fingerboard curve. It may not feel exactly like you want it, but it's the correct starting point from which to personalize your action, and it's much more accurate than eyeballing it.

With Fender's individually height-adjustable bridge saddles, the radius is automatically determined when you set the height of each string the same distance (clearance at the 17th fret) from the fretboard during the factory setup. But it's hard to read that scale (ruler) and make the adjustment—so you might find it easier to use the radius gauge to get close, and then use your ruler.

When you sight across the bridge by eye, the curve may look right even when it's not. Often the middle strings are on too flat a curve and too close to the fingerboard, causing buzzes. Also, when the saddle curve matches that of the fingerboard, you'll like the feel of the action, especially for chords. Best of all, you'll usually find that you've eliminated that final 10 percent of annoying string buzz.

Acoustic players may use the radius gauge as a guide for laying out the proper shape onto a poorly shaped saddle, and then filing or sanding the saddle to the correct shape. Saddle making is covered in the Acoustic Adjustments chapter, but I don't mean to sound too casual about the ease with which this saddle shaping can be done—don't screw up your guitar! Take care when removing and replacing the saddle into its slot, and if you lack experience, have the saddle reshaped by a professional.

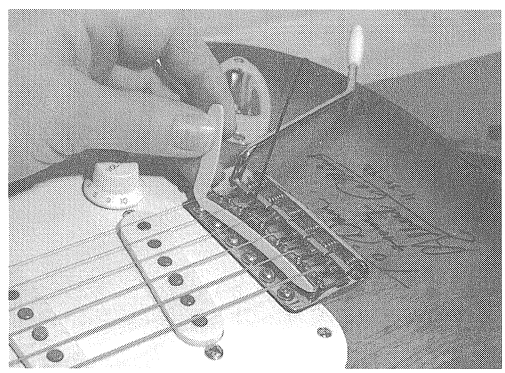


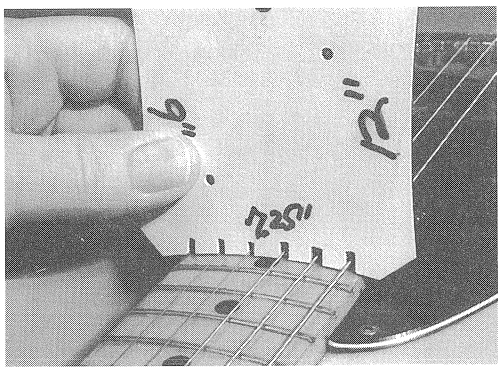
Whether on acoustic or electric, most saddles are shaped so that the strings gradually rise higher on the bass side. This compensates for the extra thickness of the wound strings and their wider, floppier vibration when struck. For this reason, I consider the perfect matching of the bridge curve as a starting point. Once the proper curve is reached with a low to medium-low action, expect to slightly raise the three lowest strings to get perfect results.

CUSTOMIZED RADIUS GAUGES

Stewart-MacDonald's radius gauge set is the perfect tool for determining the fretboard radius of most guitars, the saddle radius of an acoustic bridge saddle, and for setting the bridge saddle radius of height-adjustable bridges like Fender uses. But it doesn't fit every bridge, so:

■ I cut the corners off of my radius gauge to fit between the metal walls of a Tele bridge, and to keep from hitting the bridge base on Gibsons.





■ If you're really picky (which I am) the only *true* way to set any bridge saddle radius is to check the radius from *underneath* the strings—since measuring from the top doesn't take the height of the strings into account. On a piece of white plastic (or cardboard), use the standard radius gauge to layout the appropriate radius for a "below the string" (convex) gauge.

■ Another nice trick is to notch the Stew-Mac gauge so that it fits *over* the strings (photo above). Then you can measure a fretboard radius—or a saddle—with the strings on!

WHAT SETUP INCLUDES

All setup specs include the following measurements where applicable:

■ Maximum relief, or "forward bow."

■ String height over the fretboard (controlled by adjusting the bridge saddle height).

■ String height at the nut.

■ Bridge, tailpiece, and tremolo adjustments.

■ Pickup height adjustment.

All string height measurements (over the fingerboard, at the nut), relief measurements, and pickup height measurements are made by measuring the clearance between the bottom of a string and the top of a given fret (or polepiece) with a small 6" ruler which reads in 64ths.

Also, the following adjustments for both acoustic and electric guitars should be made (or at least checked) in the *playing position*. The measuring tools needed are a small 6" ruler or "scale" which reads down to 1/64" increments, and a set of feeler gauges.

Along with the factory specs, I include a second set of "custom" setup measurements when possible. These measurements (marked Mine) are taken from guitars that I know, either mine or a good friend's, and that are extremely good playing guitars. The second measurement always represents a lower-than-factory-action, and in my opinion is the best that you can reasonably expect from a given type of guitar.

Factory setup specifications for Gibson electrics

For long (25 1/2") or short (24 3/4") scale guitars. Sample instruments used were a factory-fresh 1993 Les Paul, and my 1961 ES-345.

Gibson Neck Relief/String Height

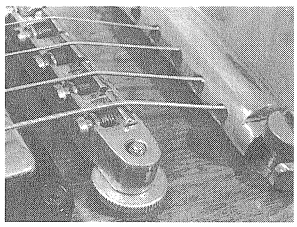
Neck relief at 7th fret	Factory	Mine
On all strings:	.012"	.004"
String height at 12th fret	**Factory**	**Mine**
On the bass E string:	5/64"	3/64"
On the treble E string:	3/64"	3/64"
String height at the nut	**Factory**	**Mine**
On the bass E string:	2/64" (.030")	(.015")
On the A string:	2/64" (.030")	(.014")
On the D String:	1-1/2/64" (.022")	(.013")
On the G string:	1-1/2/64" (.022")	(.012")
On the B string:	1/64" (.015")	(.010")
On treble E string:	1/64" (.015")	(.009")

The nut height is adjustable too. files and techniques shown in the Nut Work chapter to lower each string individually. Gibson measures the clearance between the bottom of the string and the top of the first fret using a ruler. Here I've given the distances in thousandths as well, since I use feeler gauges to take these measurements.

BRIDGE AND TAILPIECE ADJUSTMENTS

At the factory, Gibson uses a "crowbar" to quick-raise the bridge while the thumbwheels are spun up or down to raise or lower the bridge body. It's made from steel which is heated and bent to a crowbar shape and then padded with thick felt on the bend to keep from harming the top as the bridge body is pried up. If you lack this tool, you may have to de-tune the strings in order to get some thumbwheels to move (especially when raising the bridge).

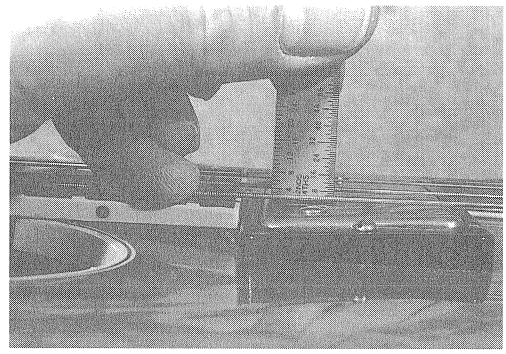
The bridge saddle radius should match, or be slightly flatter than, the fretboard radius. This can be checked with a radius gauge. Most Gibson electric fretboards range between a 10" and 12" radius, and factory bridges have a radius of 12". By cutting the string notches slightly deeper on the middle strings, a flatter radius is achieved. The same files and techniques used for lowering the nut can be used for bridge saddles (see Gibson Tune-O-Matics).



Stop tailpieces adjust by screwing the two "studs" in or out until the strings just clear the back of the bridge body. Many players go beyond this point and tighten the stop-bar snug against the body to increase sustain, but it's not proven that this works (try it). It does seem that every model, and even individual guitars within model-types, has a perfect tailpiece height where the strings and action feel best (and you get the best tone). Raise your tailpiece up and down to find the "sweet-spot." I like to see the strings clear the body of the bridge (see photo above right); they often don't when the stop-bar is screwed too far down. Trapeze tailpieces are not, for all practical purposes, adjustable.

PICKUP HEIGHT

Pickup height adjustments are best made with both volumes wide open. Switch back and forth between pickups while adjusting the height, until the volume of both is equal. Then *back off* the neck pickup a little bit to boost the power of the bridge pickup (the bridge pickup is located close to the end of the string length, where the string vibrates with less power). As a rule, when depressing the two outer *E*-strings at the last fret and measuring from the bottom of the string to the pole-piece tops, you should get the following readings:



Gibson Pickup Height

Neck pickup	Factory	Mine
On the treble side:	3/32"	3/32"
On the bass side:	3/32"	3/32"
Bridge pickup	**Factory**	**Mine**
On the treble side:	1/16"	1/16"
On the bass side:	1/16"	1/16"

Factory setup specifications for Fender electrics

THE TUNE TEST

Here are the setup specifications used at Fender to adjust most of their bass and guitar models during the "tune-test," or final setup stage of production. The tune-test adjustments include:

- Bridge height (for tremolo instruments only—clearance between bottom of bridge plate and face of guitar).
- Neck bow (Fender's term for relief).
- String height (clearance at the 17th fret).
- Nut height (clearance at 1st fret).
- Pickup height (strings pressed at last fret).

TIPS TO MAKE FENDER SETUPS EASIER

- Sight neck: Even with strings removed you can often get a good idea of how the neck is adjusted by flexing it and sighting it. Sometimes you can make an adjustment before you string up, and it'll be correct when you get to pitch (sometimes).
- Check electronics: At Fender, the very first check is to ensure that the guitar works

when it's plugged in! A dud, or one that misfires, goes back to the starting gate.

■ The capo trick: The string height and relief measurements are made with a capo installed at the first fret to eliminate the nut as a factor when setting up. Also, when capoed at the first fret, the string becomes a straight edge when pressed at the 17th fret as well (and you've a free hand to take measurements). This "capo technique" is an important part of setting up Fender instruments, and can be used to set up any guitar.

■ Preset the intonation: Fender pre-sets the bridge saddles to an approximate "correct intonation" pattern to make the final intonation adjustment faster. This insures that the strings won't be kinked in front of the saddles in case you have to move the saddles *back* while setting the intonation. For guitars or basses, set the highest (treble) string so that the center of the saddle is the exact scale-length measurement from the front of the nut. (25½" for Strat and Tele, 34" for Precision and Jazz Basses, etc.) Then "rough in" the other saddles to the appoximate intonation pattern shown at right. Now begin the setup using the Fender "factory specs" given at the end of this section.

EIGHT-STEP SETUP FOR NON-TREMOLO GUITARS OR BASSES

All measurements of string height (over the fingerboard, at the nut), relief, and pickup height are made by measuring the clearance between the bottom of a string and the top of a given fret (or polepiece).

1 String to pitch.

2 Install capo at first fret.

3 Adjust relief at 7th fret (sometimes it's the 9th fret, especially on basses) by pressing down a string at the last fret (string becomes straightedge). Expect to take the neck on and off a few times before you get it right (unless your neck is adjustable at the peghead end). NOTE: I tend to adjust my neck almost perfectly straight at this stage and go on to setting my string height. Then if it's too buzzy, I'll loosen the rod and introduce relief gradually. At the factory they adjust in the relief, period. Try both ways.

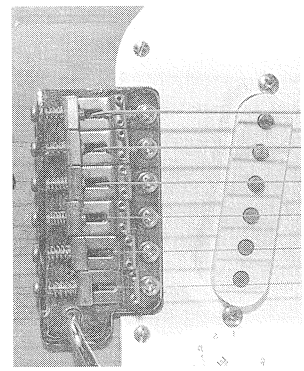
4 Set the string height across the fretboard at the 17th fret (use your ruler and follow the factory specs). Raise or lower the strings by adjusting the saddle height with the proper tool: a .050" (4-40) Allen wrench for Strats and some Teles, or a small screwdriver for other Teles and bass models. Fender saddles have two threaded set-screws; raising one screw more than another will change the spacing between strings, while at the same time raising or lowering the saddle. Keep an eye on the string-to-string spacing. The radius gauges mentioned earlier can be a big help for setting the string height/bridge saddle radius quickly.

5 Remove the capo, and set the string height at the nut (this only applies if the nut is too high—in which case you can use the tools and techniques shown later in the Nut Chapter to lower the strings. If the strings are too low, you must raise the nut with shims or replace it.

6 Set the height of the outer two polepieces to the factory specs using your ruler. Press the outer two strings at the last fret, and check the clearance.

7 Play the guitar at all frets, checking for buzzes.

8 Fine tune the intonation, and you're done!



Fender's pre-set bridge saddle pattern

TEN-STEP STRAT SETUP

Now here's the same setup as above with some added steps for dealing with the tremolo. I learned this setup in May of '92 while visiting Fender. My tour guide was Albert Garcia, a long-time friend and Fender employee. Having set up thousands of Strats, Albert knows a few tricks, which he uses on his own guitars, that are not used at the factory. Before beginning, make note of the following four pointers:

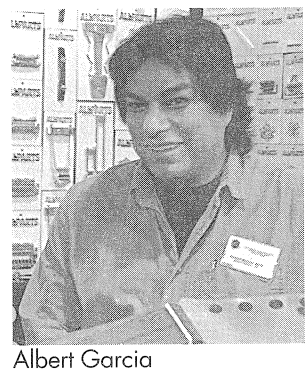
■ Again, before starting be sure that the electronics are working.

■ No springs are installed on the tremolo.

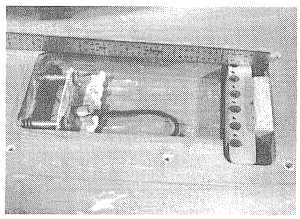
■ The tremolo claw should be quite loose (1" from the rear wall of the tremolo rout) to allow for easy installation of the springs later.

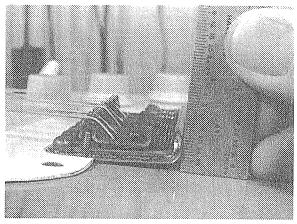
■ The intonation is "pre-set" as stated previously.

1 String up lightly, but not nearly to pitch. Use .009's for the American Standard, and .010's for the Vintage.



Albert Garcia





2 "Block" the tremolo in the middle position so it can float in either direction. Use a hardwood block measuring 1" wide and 2" long that tapers from ¼" to ½". Shove it in between the rear of the tremolo block and the guitar body until you get a gap of about 11/32" . Now string to pitch, and the tension will hold the block in place. Shove the block in, or pull it out (retuning as necessary), until a gap of 3/32" shows between the bottom of the bridge plate and the face of the guitar. Once tuned to pitch the bridge can't go anywhere—it's "blocked".

3 Install a capo at the 1st fret.

Measuring relief with a feeler gauge.

4 Adjust the neck. In the playing position, depress one of the wound strings (I use either the *D* or *A*) at the 17th fret. Adjust the neck to the proper relief, or straight if you prefer it that way. (Both Albert and I prefer a neck to be almost straight, or maybe with just a *little* bit of relief—.004" to .006".)

If you have a neck which adjusts at the body end, you may have to remove the neck a number of times to complete the adjustment. At the factory, they seldom have to take the neck off more than twice—they're good at it!

5 Set the string height. With the capo still on, adjust the string height at the 17th fret to match the specs in the chart—you can do that one of two ways, with the same result: A) set the outer two *E* strings to the correct height and use the radius gauge to set the remaining bridge saddles; B) use the ruler to measure and adjust the height of each string until it shows the same clearance all the way across at the 17th fret (bottom of string to top of fret). The factory clearance is 4/64"for guitars, but Albert sets his bass *E* string slightly higher to 5/64" and then blends that into the 4/64" height using the radius gauge.

6 Remove the capo.

7 Lower the string height at the nut to match the factory specs. This is generally set between .022" and .020", but if you really want to be exact, there is a range from .018" to .022" depending on whether you're working on a guitar or bass. You'll notice in the chart a plus (+) or minus (-) figure. The (+), when indicated, gives the measurement for the low bass string, the (-) indicates the treble string setting. For example: .020" (-.002") means that you set all the strings at .020", but the treble *E* string *could* measure as low as .018" (guitar). Or, .020" (+.002") means that all the strings are cut to .020", but you *could* leave the low *E* string as high as .022" (bass). It's always best to go with the tallest measurement and "fine-tune" the nut by degree. Follow the techniques for making and fitting a nut in the "Nut Work" chapter.

8 Adjust the pickup height. Use the measurements in the chart; and fretting the outer two *E*-strings at the last fret, measure the gap between the bottom of the string and the top of the *E*-string polepieces. Albert prefers to set his pickups slightly farther away from the strings than the factory does, to avoid overtones and possible intonation problems and to give that "clear as a bell" Strat tone.

9 Play the guitar and check for buzzes at every fret (there could be a need to dress the frets—or perhaps only one—on any guitar, at any stage). Albert sets his final intonation at this stage, while the tremolo is still blocked—it's quicker to do it now (before the tremolo springs and string-tensions get involved).

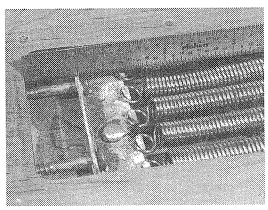
10 Install three tremolo springs and begin tightening the "claw." For heavier gauge strings, or a stiffer tremolo, use more springs. Strats come with five springs if you want to use them all (Stevie Ray did). Because the wooden spacer block (wedge) isn't too wide, you should have access on each side for the long Phillips-head screwdriver used to tighten the spring claw. And since the claw is loose, nothing will happen to your set-up because the springs won't pull on the tremolo block until they get close to the right adjustment. On

Factory Specs For Fender Setups

Model	Pickup Height*	String Height**	Bridge Height	Relief at 7th fret	Nut Action***
Amer. Standard, Vintage, & SRV	1/8" bass side 3/32" treble side	4/64"	3/32"–1/8"	.012"	.020" (–.002")
Ultra, Plus, Beck	1/16" both sides	4/64"	3/32"–1/8"	.012"	.020" (–.002")
Burton Tele, '52 Tele	3/32" bass side 5/64" treble side 10-12/64" middle	4/64"	n/a	.012"	.020" (–.002")
Malmsteen	1/8" bass side 3/32" treble side middle flush w/pickguard	4/64"	3/32"–1/8"	.008"	.020" (–.002")
Clapton	1/16" both sides	3/64"–4/64"	flat on body	.008"–.010"	.020" (–.002")
SRV	1/8" bass side 3/32" treble side	4/64"	3/32"–1/8"	.012"	.020" (–.002")
Floyd Rose Classic	1/8" bass side 3/32" treble side 3/32" both sides for humbucker	1/8" use pivot screws to even out action	7/32" (±1/32") top of bridge plate to top of body (4/32" ±1/32") measured at pivot screws	.012"	.020" (–.002")
5 String Bass	7/64" bass side 5/64" treble side	3/32" (±1/64")	n/a	.014"	.020" (+.002")
Amer. Standard & Vintage Bass	1/8" bass side 3/32" treble side	3/32" (±1/64")	n/a	.014"	.020" (+.002")
Ultra & Plus Bass	1/16" both sides	3/32" (±1/64")	n/a	.014"	.020" (+.002")

* Pickup height refers to the gap between the string and pickup when the string is pressed at the last fret
** String height measured at the 17th fret
*** Nut action measured from bottom of string to top of first fret

On American Standard type bridges, the saddles on strings 1 and 6 should be 1/32" to 3/32" above the bridge plate. Saddles on strings 3 and 4 should be 3/32" above the plate, and the other two fall in-between.



most Strats, the tremolo claw is in the approximate correct adjustment range when you have around a 21/32" to 5/8" clearance between the claw and the cavity wall. Once the springs get to the right tension, they take control of the bridge and the wooden block loosens (no longer "blocking" the trem-olo), and pulls right out. You're done! The block will loosen at the *exact* moment the springs come into play.

If you've done everything correctly, you should have a great-playing Strat! If you didn't fine-tune the intonation after Step 9, do it now or play it the way it is (the factory's "rough" setting is actually quite close).

Electric Bass Setup

Although the eight-step setup just mentioned applies to both guitars *and* basses (and not just Fender basses), here's some more setup info just for bass players. I borrowed this from the pages of *Bass Player* magazine.

The electric bass has come a long way since Leo Fender introduced the Precision Bass in late 1951. You might say the electric bass has come of age, with companies such as Pedulla, Tobias, Steinberger, Modulus Graphite, Ken Smith, Alembic, and others *specializing* in electric 4-strings and offering extremely high-quality 5-strings, 6-strings, headless, fretless, and other models as well.

Bryan Galloup using the neck jig

A neck jig is a big help in fretting and setting up the electric bass.

Bass players have evolved along with the instrument, with a whole new range of percussive and/or melodic styles of playing. Now more than ever, proper setup is the key to getting the best bass for the buck. When your bass is set up properly, it means that the nut, bridge, and neck have been adjusted to obtain the best action possible for your playing style and choice of string gauge. With a little practice, you should be able to make most of these adjustments yourself. Here's an outline for getting your bass to play its best, followed by a description of the important steps:

1 Install the strings you prefer. If the bass is new, play it awhile to get the feel of its action.
2 Sight the neck; look for straightness or relief.
3 Make basic neck adjustments before adjusting the nut or bridge.
4 Adjust the bridge and nut together.
5 Re-check the neck adjustment.
6 Adjust the pickup height.

With Fender slab-style necks that have no headstock angle, install the strings with enough downward wraps to create good pressure on the nut. Basses with angled headstocks require fewer wraps to achieve good down pressure. Expect to go through several sets of strings until you find what's right for you. Begin with the manufacturer's string recommendation, and go from there. These basics may help you choose a set:

■ String tension is important. Equal tension from string to string gives a balance that feels right to both the fingering and plucking hands. For hard-to-adjust necks or those that tend to have up-bow, choose a light-gauge, low-tension string. Within a given gauge (regular, medium, light, etc.), flat-wound strings have the highest tension, half-rounds the second highest, and round-wounds the least tension.

■ Round-wound strings are bright in tone and easy to intonate, but cause finger squeaks. They have the most fret buzz.

■ Flat-wounds eliminate finger squeaks, but trade off tone and brightness. They're harder to intonate, but have a good ol' upright sound.

■ Half-rounds combine flat and round shapes into a string with low finger noise, decent brightness, and good intonation.

■ Core-contact (or "taper-core") strings have an exposed *core* that contacts the saddle rather than the outer string wraps. Some bassists feel that these are easier to intonate.

■ If you're a 5-stringer looking for the optimum low-*B* string, D'Addario's Jim Rickard, noted expert on all matters related to guitar design and construction, recommends a .145" gauge.

String height at the nut is critical. If the nut's string slots are too deep or the nut itself is too low, the heaviest strings are sure to buzz against the 1st fret. With a little luck, after any neck adjustments are made, you'll still have a nut that's slightly tall, allowing you the option of lowering the strings a bit. But if the strings are too *low* at the nut, have a new nut made or the original shimmed. Removing a nut without breaking it can be difficult, so leave this work to a professional.

Measure string height at the nut between the bottom of the strings and the top of the fret. A *low* action measurement taken this way would read: *E*–.035", *A*–.030", *D*–.025", *G*–.025". When I make a new nut, I stop lowering the strings at .050" on the *E* and at .030" for the *A*, *D*, and *G*. From that point I prefer to lower the strings gradually, with a customer's specific attack and playing style in mind.

Players with a strong attack, especially those using slap-style techniques that pull the string up and almost out of the nut slots, should use a fairly low-profile nut with string slots that aren't too deep. This way, the edges don't break off as the string is strained in its slot. From half to a third of a string's diameter is a good depth for the string slots. While bone is a preferred nut material for guitars and many basses, if your style is hard-hitting, stick to resilient plastic, graphite, or phenolic materials, which have a reduced chance of breaking.

Bridge adjustments aren't hard to make but are certainly no piece of cake, either. Expect to spend several hours getting things right, and if your first attempts aren't perfect, it's worth your while to keep on trying. A delicate balance exists between neck, nut, and bridge, and their combined effect determines your action. Bridge setup controls the height of the

strings, matches the curve of the saddles to the fingerboard radius, and sets the intonation. Here are the basics:

- String height is raised or lowered at the saddle by adjusting small set-screws with an Allen wrench or screwdriver.
- Lengthwise saddle travel controls intonation. If a string notes sharp at the 12th-fret octave, move the saddle back away from the neck. If a note is flat, move the saddle forward toward the neck.
- Matching the arch of the saddles to that of the fingerboard makes the action comfortable to both hands. A radius gauge for measuring fingerboard and bridge comparisons is a handy setup tool.
- For low action and the least fret rattle, combine these approaches: 1) Get the neck as straight as possible with very low action, and then eliminate any buzz by loosening the truss rod to add relief. 2) Straighten the neck and then eliminate buzz by raising the bridge inserts. Once you see the effect of both methods, *combine* them for the best action and least buzzing.
- Remember that some buzz between metal strings and metal frets is normal.

String height measurements vary from manufacturer to manufacturer. I discussed bass setup particulars with a panel of experts: Michael Tobias, Ken Smith, Roger Sadowski, M.V. Pedulla's Brett Carlson, and Bob Malone at Alembic. All of their string height measurements are between the bottom of the string and the top of the fret, and here's what they had to say:

Michael Tobias: "We never measure, because each bass is different. But our setups *start out* with ⅛" at the last fret all the way across, following the fingerboard radius (15" to 17"). This gives a height of 1/16" to 3/32" at the 12th fret. When you press a string at the 3rd fret, it should clear the 1st fret by .010" or .012". No bass will play without some relief. As a measure, hold down a string at the 1st and 15th frets—you're using the string as a straightedge—and adjust the neck until, at the 8th fret, you can just slide a Fender thin pick in between the string bottom and fret top; that's your relief. Our stock strings are private label in .040", .060", .080", and .100" gauges."

Ken Smith: "I use taper-core Ken Smith strings on all but the *G* string, in gauges of .044", .063", .084", and .106". You must have relief, between 1mm and 2mm at the 9th fret, even up to 1/16" at times. Really, all basses must be set up on an individual basis. I don't actually measure string height at the nut, but prefer an action where a player can depress a string without having to press hard, and with no buzzing on an open string. I consider a *low* height at the 12th fret to be 1/16" all the way across."

Roger Sadowski: "I shoot for a mostly straight neck with a *little* relief, and prefer a string gauge of .045", .065", .080", .105". My standard setup is for the string height at the 12th fret to be on the fat side of 5/64" for the *G*, and 3/32" for the *E*—measured from the bottom of the string to the top of the fret."

Brett Carlson: "We use relief, except on fretless models—with those we get the neck perfectly straight. Our relief, measured by holding down a string at the 1st and last frets, is set at .015". String height at the first fret is .025" under each string, and at the 12th fret I shoot for 3/32" under the *G* and 5/32" under the *E*. All our nuts are brass, so we don't have a problem with the string slots breaking. Our standard strings are D'Addario round-wounds in the .045", .065", .080", and .100" gauges." (Brett's .015", by the way, is a *slight* relief.)

Bob Malone: "In a setup you can't go beyond what you have to work with. It all comes down to how straight you can get that neck. If you can get it straight to begin with, then your setup can go from there. I like a very slight relief, but I don't measure it; it's all by feel. For nut height, when a string is pressed at the 3rd fret, it should just barely touch the 1st fret. Alembic basses are built with brass nuts."

Finish up by adjusting the pickup height to suit your tastes (just don't raise them so high that the strings either slap against them, or get pulled into the upper frets by the magnets). Remember that none of us learned these tricks overnight, so be patient.

That's it! If you've followed these basic setup

Bass necks are the hardest of all to adjust, keep straight, and refret. They're so long, it's hard to expect a truss rod to keep all that straight.

tips, you've also encountered most Strat, Tele, and Fender Bass problems, eliminating them as you went along. Problems other than these and certain custom modifications—even fret work—can involve altering a vintage instrument. In cases like this, the choice is yours. There is certainly no disputing the fact that collectors of vintage Strats want them as mint and untouched as possible, and some are broken-hearted if you've even blown the dust off the pickups or from under the bridge saddles. So you could drastically affect the value of your guitar by performing anything other than stock maintenance. If in doubt, contact a pro, and basically don't remove from, or add anything to, a vintage piece without first getting permission.

Special thanks to Jim Werner, who was extremely helpful in steering me toward many of the repairmen and collectors contacted on the subject of Strats. If you're interested in Jim's list of Fender instrument serial number and neck dates, contact him at R.R. 1, Box 236, Letts, IA 52754. Jim works hard to preserve the past, and we can all thank him by sending him any information on Fender instrument serial numbers, neck dates, models, colors, and other pertinent features that help date an instrument to a specific era.

Fender Guitar Neck Profiles

Here are two articles that ran in *Guitar Player* and *Bass Player* magazines respectively, that will tell you all you need to know about the shape of bolt-on necks. Fender set the standards for bolt-on neck guitars. If you look around the industry you'll find that every manufacturer copies the depth, width, and "feel" of Fender necks (many would copy the peghead shape too, if they could get away with it). Understanding the cross-sectional shape, or "profile," of Fender necks will help you choose an instrument—new or used.

TALKING NECK SHAPE AT THE CUSTOM SHOP

During a visit to the Fender factory and Custom Shop in Corona, California, I *finally* understood the terminology used to describe Fender neck shapes (or "profiles"), something you must know when buying a guitar. A neck's shape, front-to-back thickness, and fingerboard width determine whether or not the guitar feels good to *your* hand and style.

LETTER-STAMP DESIGNATIONS

Many different terms, such as "boatneck," "V," "oval," and A, B, C, and D designations, have been used to describe Fender necks. Custom Shop master builder Jay Black helps clear up the mysteries: "The letters A, B, C, or D that were stamped on the end of necks from the early '60s until around 1973 refer to neck *width* at the nut—not shape. So when people say they've got a 'C' neck—referring to its shape—they're wrong, although early-'60s Fender necks *are* somewhat C-shaped in profile. But we call that 'oval.' The *only* letters we use when talking shape are 'U'—the shape of that real early '51 to '53 Tele—and 'V' for the triangulated shape. Neither of these letters were ever stamped anywhere on a Fender neck. The corresponding nut widths for the old letters are: A=1 ½", B=1 ⅝", C=1 ¾", and D=1 ⅞". Currently, all production vintage necks have the B nut width, while the American Standard is slightly wider, falling between the B and C measurements at around 1 $^{11}/_{16}$". In the Custom Shop, we'll make anything you want."

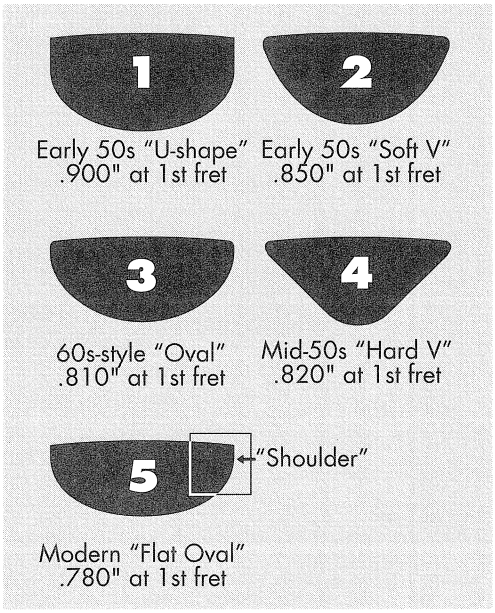
"Boatneck," an archaic term used for describing certain neck profiles, is a misnomer because it's been used by too many people in too many ways. As Jay explains, "When Fred Stuart, one of our master builders, uses the word boatneck, he's referring to the older Martins, Washburns, and many big V-necked guitars, so we're trying to drop the word from our vocabulary. But if you *have* to use the word boatneck, you'd be talking about a #4 or a #1056 neck."

THE FIVE BASIC GUITAR NECK SHAPES (PLUS ONE)

Due to the use of less-sophisticated machinery and subsequent hand-shaping, old Fender neck profiles are so subtle in their differences

that it would be virtually impossible to produce them all. So Fender has agreed upon five basic "generic" neck shapes based on specs from the '50s and '60s. "Today's production necks are made from specific templates on machinery that is very consistent," Jay Black explains. "This is especially helpful with production models because the neck on any new SRV model will be identical in feel to Stevie's 'Number One.'

"Right now the Custom Shop will shape any neck that a customer requests, but most players want one of the five basic shapes. By using these generic shapes as a reference point, we can cover everything from 1950 all the way up to '62. Anything other than that is usually made from an oversize blank and hand-shaped to what the customer wants, using the five shapes as a means of communicating with the customer. Some players have a qualified local luthier measure a favorite neck and send us the specs to work from."



PRODUCTION NECK SHAPES

Here are Fender's basic neck shapes:

No. 1. Essentially a round, chunky, '53 Tele shape—the "U" shape, with lots of shoulder.

No. 2. Also called the "54" or "soft V," it has *some* shoulder, but less than No. 1. It's not quite as deep from the top of the fingerboard to the back of the neck, but it's still a fairly chunky neck. Vintage '54 necks varied quite a bit. Eric Johnson's '54 Strat has one of the smallest front-to-back dimensions Jay's seen.

No. 3. The 1960 and '62 "oval" shape. Thinner, front to back, at the 1st fret than at the 12th, it has a very oval (or you *could* say "C"-shaped) bottom. "We can alter the No. 3 to produce the '63 or '64," says Jay. "This is a slightly beefier version of the same shape, except the 1st-fret dimension becomes thicker by .030" or .040"."

No. 4. Different from the large, soft No. 2, this is a "hard V" that's .030" thinner front to back. You'll find this neck on Strats from late '56 and '57.

No. 5. The contemporary "heavy metal" style neck. Not used too often, it's similar to the '80s necks on Jackson, Charvel, Ibanez, and other models. It's a much flatter, very non-traditional neck, and its shape changes as the trend changes.

No. 1056 (not pictured). Patterned from a "10-56" neck (referring to October, 1956), this is a very big V neck. '56 necks generally had a small V, but they made plenty of chunky ones too. "If anything could be called a boatneck," says Jay, "it would be this."

MORE ABOUT NECK SHAPES

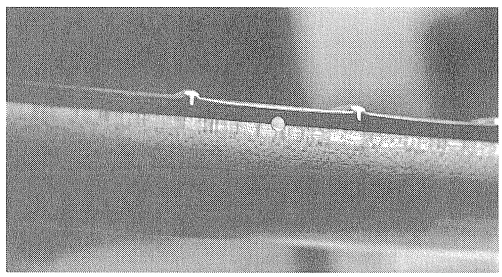
Fender Custom Shop builders John Page, Jay Black, and Larry Brooks went on to answer some other questions that I had.

Are most Fender Strat necks based on one of the five basic "generic" shapes?

John Page: Yes. With modern machinery and setup techniques, we can alter the patterns slightly to make one model quite different from another—consistently. So one pattern can be responsible for a variety of shapes. Our most popular Custom Shop neck shape is the #3, and most production necks are based on that pattern too. Our model "1962" Strat has a neck based on the #3 pattern, but with a slight alteration in dimension from top to bottom to make it thinner and different-feeling from the American Standard or SRV models, which are also made from the #3 pattern. The American Standard Strat, designed by Dan Smith, is a #3 variant that's wider at the nut and has a little more shoulder (the area from the fretboard edge to about a third of the way down either side of the neck).

Above: Larry Brooks with SRV signature Strat. At right: Art Esparza, Steve Boulanger, Ralph Esposito, Fred Stuart, Dan Erlewine, Jay Black, Yasuhiko Iwanade, Larry Brooks, John Page.

Larry Brooks: The "Stevie Ray" also starts with a #3 pattern, but we flattened the fretboard radius from the vintage 7 ¼" to a 12" curve, which removed some of the fretboard's thickness and changed its feel. And we added a little more meat to the shoulder to fatten it up—more like a '63 or '64 vintage Strat. Stevie wanted a Custom Shop Strat to take the place of "Number One," which had been broken too many times. The neck shape was critical, especially the "round-over" (edge of the rosewood fretboard in the shoulder area). It had to be smooth, polished, and as worn-feeling as the original.



Do production SRV models have that worn round-over?

Brooks: They are machine-shaped like Number One's worn shoulder, but without the hand-shaped and polished vintage round-over along the fretboard. Not every customer would want that worn, vintage round-over, since it removes wood and reduces the neck's dimension and longevity. I did shape it on Stevie's, though. You could take a new SRV model to a good luthier and have the edges smoothed and rounded-over quite easily.

Why did Stevie want a 12" fretboard radius, when Number One was made with the 7¼"?

Brooks: Rene Martinez, Stevie's guitar tech of many years, had refretted Number One so often that the fingerboard evolved into the flatter 12" radius, a result of minor sanding and leveling of the board when the frets were removed. A flatter radius means less noting-out during bends, and Stevie liked that. And Stevie had played—and enjoyed—Bonnie Raitt's brown Strat, which also has a 12" radius. So he requested a 12" radius and the tall Dunlop #6105 fretwire. Rene sent the guitar back to us after Stevie's death so that we could get the production model exactly right.

Jay Black: The Eric Clapton model's neck shape combines the #2 and #4 patterns. It's as large as the #2, but with a little more "V" like the #4. It has a 9 ½" radius for easier blues bending and is fretted with a thin vintage-style wire measuring .085" wide by .045" tall—much like Stewart-MacDonald's #148 fretwire." (Author's note: All Custom Shop and American Standard products feature a 9 ½" radius fretboard. The only Fender guitars currently being built with the old-style 7 ¼" radius are the '62 and '57 vintage Strats and the '52 vintage Tele. In fact, Jay Black says that over the past four years and 500 guitars, he's only had three customer requests for vintage 7 ¼" radius necks. The 9 ½" radius is a nice compromise for most players.)

I've played fatter '50s necks that seemed to have more shoulder on the bass side, and almost none on the treble.

Black: Because of the amount of hand-shaping done back then, you'll find some old Fenders with an asymmetrical shape. That extra shoulder gives good support to some hands. It's often a real help to sufferers of carpal tunnel syndrome. A hard "V" on the bass side doesn't please a player with carpal tunnel, whereas the chunky shoulder supports the hand.

Fender bass neck profiles

A bass neck's shape (or profile) is as important as good fretwork in determining whether or not a bass feels good, plays well, and suits your style. To better understand Fender Page (again), the head of Fender's Custom Shop and

R&D department. He directed me to the neck specialists on his staff: senior R&D engineer George Blanda, and Custom Shop master builders Jay Black, Mark Kendrick, Fred Stuart, and Yasuhiko Iwanade. Yasuhiko, in turn, introduced me to his friend and "bass mentor," Albert Molinaro of Guitars R Us in Hollywood. Among the seven of them, there's not much about the Fender bass that isn't known!

THE FOUR BASIC SHAPES

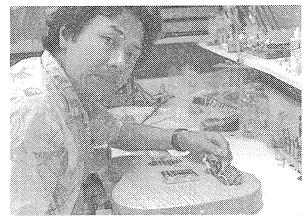
Fender recently specified four basic neck shapes for bass, based on specs from the '50s and '60s (chart, page 42). Any Fender neck—whether it's vintage, production, or custom-made—relates somehow to these shapes. In one of several conversations, Fender's Jay Black reminded me that "the four shapes didn't exist during the vintage years, but we realized that the neck builders in both production and the Custom Shop needed to be speaking the same language. And since the Custom Shop will make almost any neck you want, it was even more important to set shape standards for communicating with our customers. So we selected the four most popular neck shapes, ones that would cover everything from the '50s through the '60s—the necks made later were simply variations. The satisfaction of our bass-playing customers proves that we chose the right shapes."

A BRIEF HISTORY OF THE BASS

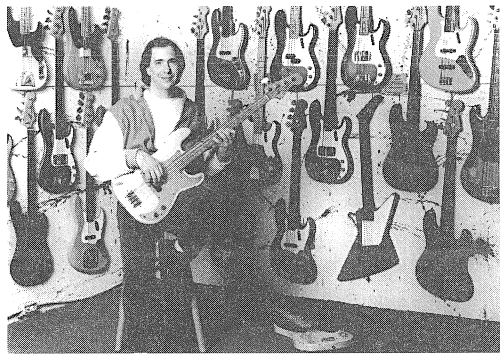
Yasuhiko Iwanade (his friends call him Yas) handbuilt the '51 Precision reissues made by the Custom Shop in 1991, a short "production" run of 82 instruments. He even hand-wound each pickup! Word is that it couldn't have been done better by anyone, and that Yas is an acknowledged expert on Fender history—basses in particular.

Yas got to know Leo Fender himself before Leo's death in 1991, and he told me what the company's founder explained to him about the early days. "Even though the same cutters were used to shape both guitar and bass necks, the shape of guitar necks and bass necks made even on the same day in 1954 would be quite different from one another," Yas notes. "This is because P-Bass necks are wider than guitar necks, and the machine's cutter couldn't reach as far toward the center of the back of a bass neck. Therefore it carved them differently.

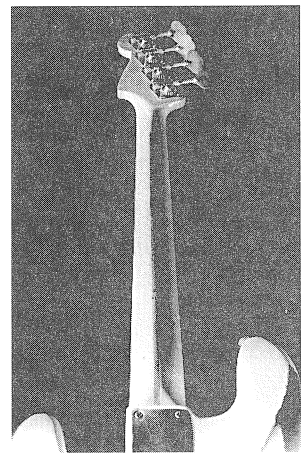
"Of the four generic profiles" continues Yas, "the neck shapes that most Fender bass players talk about are the round or U-shape, the soft-V, and the oval. I've seen only a few hard-V bass necks, but you should ask Albert Molinaro about them."



Yasuhiko Iwanade



Albert has a collection of 75 vintage Fender basses, so I checked in with him next. "Fender set the standards for neck shapes that bass guitar manufacturers worldwide would follow," notes Albert. "As they went through the '50s, the necks evolved from big, round, and chunky to flat, wide, and smooth—possibly to accommodate the changes in music. There definitely were hard-V necks on basses, although I haven't seen many. I have two of them, both made in 1957 (photo at right). I don't like the feel of them too much, though—they're too skinny."



Yas and Albert compared notes to decide what to call two other profiles (not from the "generic four") that were used during the '70s and early '80s. "Both shapes are simply variations of the round, or U, profile," explains Albert, "with the later bass having a sharper round-over."

STILL HANDMADE

"Handmade" is a term often used to describe a quality musical instrument. With the use of more sophisticated machinery and the four standard shapes to control consistency, I wondered if the handwork that made the old necks special had become a lost art. George Blanda works closely with production, so I asked him: *George, is there any hand-shaping on production necks today?*

"In essence," he responded, "our necks *are* handmade, when you get down to the details. The machines remove everything but the critical few thousandths of an inch that are still done by hand. All transitional areas, such as the headstock, butt, and fretboard wrap-around—any place where a machine cutter enters or exits the wood—are still finished by hand. In other words, the things that really give the neck its feel are done by hand. In fact, neck-shaping is one of the most important positions in our guitar factory. We use the most experienced employees; many have worked here for twenty years or more. The machinery just gives these skilled people a more consistent piece to start with.

"Currently all production P-Basses have the B [1⅛"] nut width, except for the Vintage Precision reissues, which have the C [1¾"] width. And Yas is right about the oval profile being the most popular shape—it has now become the standard shape for *all* production bass necks, including the Vintage Precision reissue. The Jazz Bass, whether a Vintage reissue or contemporary, still has the A [1½"] width, and it never strayed from the oval shape, even in the '70s and '80s, when the Precision changed. A player wanting the old U, V, or other shape can contact the Custom Shop."

BASS FUTURES

I asked George Blanda and Fred Stuart about the future direction of the Fender bass. "The Urge (Stuart Hamm model) represents our current thinking on bass design," said George. "It began as a Custom Shop project; as it developed, there was a lot of excitement, and production got involved.

"It's good for us to do new things. It was always true that if you could have only one bass it had to be a Fender, and we'd like to keep it that way. We recognize the requirements modern music places on electric bass, and we're offering instruments to fill that need. Take the P-Bass and J-Bass Plus instruments—these basses are very reminiscent of their predecessors, but they have 22 frets, downsized bodies, and Lace Sensor pickups. We knew that players who didn't play our traditional basses tended toward smaller instruments, so we responded to that."

Fred Stuart has made lots of basses at the Custom Shop. "Most of them have been left-handed ones," he says. "The typical left-handed bass player is buying a Fender for the historical significance: perhaps he had a P-Bass back in the '60s and wants to recapture that. Being a lefty makes it that much harder to find a bass on the vintage market, and Fender isn't offering the Vintage P-Bass or J-Bass reissues for lefties. We've gotten so many orders we even have a standard price for a left-handed bass ordered through the Custom Shop.

"The Jazz Bass and Precision have their own sounds—and that's what many people are looking for. When they think of a contemporary bass they don't always think of Fender, but perhaps they should. I guess it's just a matter of time—we need to let people know what we've got and that we're serious about it. At this point, we've got a lot of the elements in place for reaching a new market, so a first-time bass player who doesn't go for the Jazz or Precision can still start out with a Fender bass. There's something special about that!"

Many thanks to Albert Molinaro of Guitars R Us, 7404 Sunset Blvd., Hollywood, CA 90046; (213) 874-8221. Albert was a big help as I was writing this article, and he loaned us the beautiful photographs of basses in his collection.

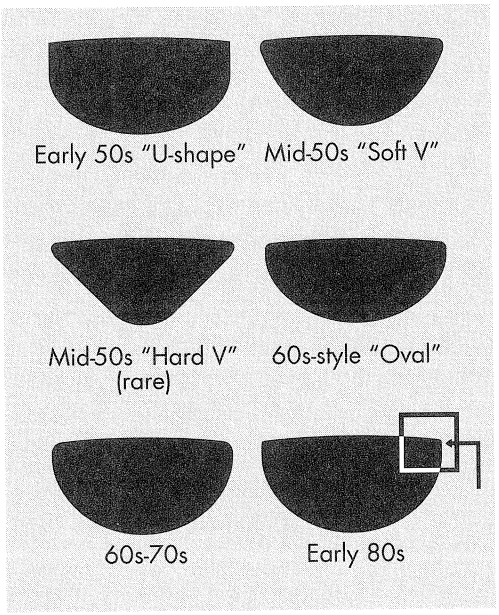
THE EVOLUTION OF THE FENDER BASS NECK

Fender has changed the shape of its bass necks five times over the years. Here's how Yasuhiko Iwanade of the Custom Shop charts the development:

Early '50s: U shape. Round and chunky.

Mid-'50s: Soft-V shape. That is, a more rounded V than the hard V, which had a pronounced ridge down the center. Some hard-V necks are found on basses from late '56 and into '57, but they're quite rare.

Late-'50s to Mid-'60s: Oval shape. These were the widest of all Fender P-Bass necks: 1¾" at the nut. The depth (thickness) was reduced considerably, so they feel very flat and wide. Although the Jazz Bass, which first appeared during this era, shared the same oval shape, it feels more like a U in the lower positions due to its narrow (1½") nut. The oval



is the most popular of all Fender bass necks.

Late '60's through '70s: A variation of the original U shape—narrower than the '60s oval necks, not quite as chunky as the early-'50s U shape and with no hint of a V.

Early '80s: Very similar to the '70s U variation just mentioned, but sharper on the fingerboard edge, or "round-over." The early '80s necks became very wide again, reminiscent of the early '60s P-Bass but with a different shape.

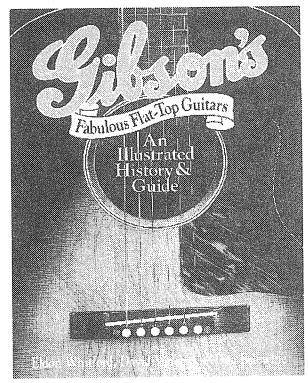
1985: All bass necks returned to the oval shape—still used in production today.

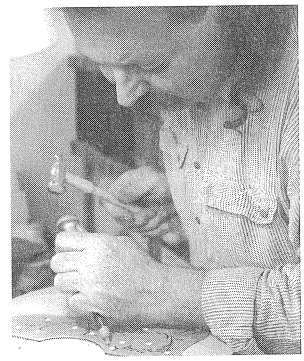
Acoustic guitar setup using factory specs

The measurements about to be given apply to all Gibson flat-tops made from the 1930's to the mid-'60s, and for those made in Montana from 1990 until the present—the eras when Gibson made (or makes) great flat-tops. I "skip" the late '60s, the '70s and '80s because those were not the best years for Gibson flat-tops, and many flat-tops (not all) made during that era did not, and could not, conform to these "factory specs." If you'd like to understand why, and learn more about Gibson flat-top history, read the book *"Gibson's Fabulous Flat-Top Guitars—An Illustrated History & Guide"* written by Eldon Whitford, David Vinopal, and myself (published by Miller Freeman Books).

GIBSON FLAT-TOPS

"Gibson Montana," the company's new acoustic guitar division, was established in Bozeman, Montana in 1989. There in Bozeman, Gibson is building even better flat-tops than during the "Glory Years" of the 1930s—and that's saying a lot! The following measurements came by way of Ren Ferguson, a master builder and head of Gibson Montana's "Custom Shop." Ren, and his right-hand man John Walker are the builders responsible for resurrecting Gibson's flat-top heritage. These factory specs apply to all good Gibson flat-tops. The "Mine" specs are taken from an original, well broken-in 1940 J-35, and reflect the lowest "normal" action you'd expect from a well set-up Gibson flat-top played by an acoustic, not an electric, player. Two acoustic checkpoints which weren't needed for an electric are: 1) "saddle protrusion," or the amount of saddle height above the top of





Ren Ferguson

John Walker

Factory Specs For Gibson Flattops

Maximum neck relief at 7th to 9th fret	Factory	Mine
On all strings:	.012"	.004"

String height at 12th fret	Factory	Mine
On the bass E string:	6/64"	4/64"
On the treble E string:	4/64"	2-1/2/64"

String height at the nut

These measurements differ from Gibson's Nashville electric setups. The strings are left somewhat high so that final adjustment to suit the customer can be made by the music dealer after the sale. Measured from the bottom of a string to the top of the 1st fret with a feeler gauge, the strings are factory-set to .030". On my guitar, the treble side is .012", and the strings follow a radius to the bass side: .020".

Bridge saddle protrusion

The saddle should have from 1/8" to 1/4" showing above the top of the bridge at its highest point (the saddle will vary in height because of its radius). I consider 1/4" to be the *absolute limit* in saddle height for any acoustic guitar, and 3/16" is a better limit. My J-35 measures 7/32".

the bridge (because a good string angle over the saddle is important to achieve tone and power), and 2) the thickness of the bridge.

I always prefer as straight a neck as possible—especially on flat-tops. That isn't to say *you* won't need, shouldn't try, or won't like, relief. But experiment with getting the neck perfectly straight first. If there are no buzzes, and you like the feel, cool. If you've got problems with string buzz, *slowly* add relief until you're happy.

OBSERVATIONS (AND OPINIONS) ABOUT GIBSON FLAT-TOPS

■ Vintage Gibsons, unknown to some, have become as highly prized by many of us as Martins. Be careful what jobs you attempt on them until you know what you're doing—less is better.

■ The Gibson 12" fretboard radius is a good average between the vintage 7 ¼" Fender and the 16" Martin.

■ For me, the short-scale Gibsons make better blues guitars than their long-scale models.

■ Most older Gibsons (1930s until the late 1950s) seldom need neck resets.

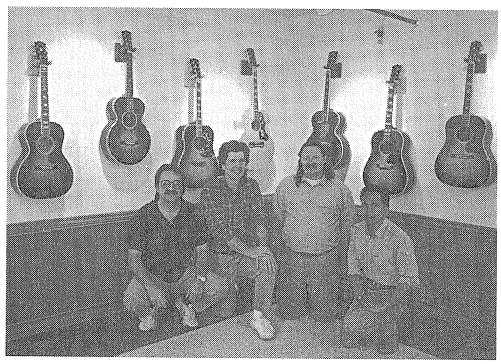
■ It's common for a Gibson to have loose braces, and as a rule, the top and back braces of vintage instruments are not tucked deeply into the "kerfing," or lining that connects the sides to the top and back. Because of this, the braces often come loose, especially toward the ends (this allows the top or back to crack).

■ Gibsons don't normally have the severe "bellying" problems around the bridge sometimes found in other steel-string guitars. Instead, Gibson flat-tops usually have a graceful arch in the top, until the early '60s (from the '60s until 1983, Gibson tops have shown a considerably higher percentage of loose bracings and top problems in the bridge area).

■ The interior structure, design, and bracing of Gibson flat-tops made during the "bad" years mentioned above can be horrendous (huge plywood bridge plates, enormous braces, sloppy work, warped tops, horrible neck sets, impossible action, and poor tone are just some of the symptoms).

■ Most great Gibson flat-tops, with the exception of several models like the Advanced Jumbo and the SJ-200 (J-200), and certain Hummingbirds made during the 1960s, have short (24 ¾") scales. The short-scale "Great Gibson Flat-tops" I'm referring to include (to name just a few) the L-0, L-00, Jumbo, J-35, J-45, S-J, J-50, and others. Although the bodies of the "Jumbo" or "J"-models are comparable in size to the Martin dreadnaughts, the string length isn't. So don't expect them to play like, or sound like, long-scale guitars. For playability, compare these guitars (if you must) to the short-scale (24.9") Martin "0," "00," and "000" models. Even then you can't compare the two guitars since the Gibson has a larger box! It's important to understand this when trying to relate to a customer, or if you're looking to buy an axe.

■ Gibson is making better flat-tops now than ever before—thanks to the guys shown here.

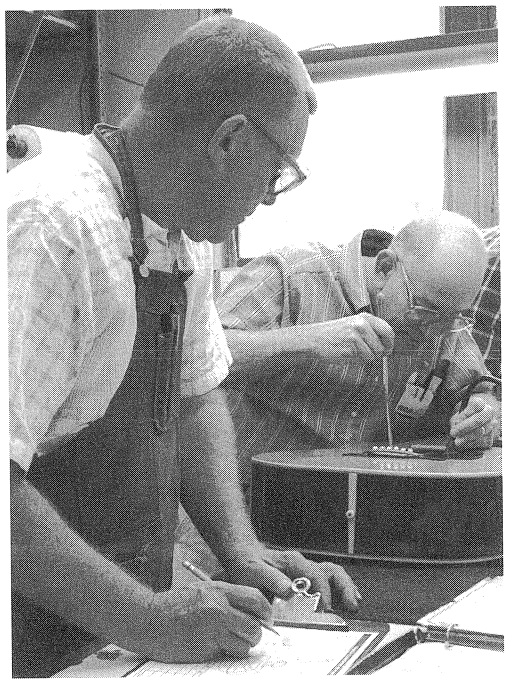


Larry English, Gary Burnette, Ren Ferguson, and Robi Johns.

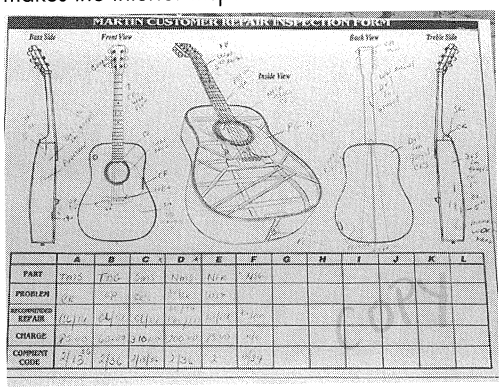
MARTIN FLAT-TOPS

It's not true that "Only A Gibson Is Good Enough." In 1961 I bought my first really good flat-top guitar—a Martin 00-28 K. It was a lovely guitar made from Koa-wood, a type of curly mahogany that grows in Hawaii. Since that time I've owned at least 30 Martins and loved them all. To this day I'd hate to have to choose between my Gibson J-35 and my old D-18. I just couldn't do it. They're different guitars and I play differently on each of them.

For playing some of the old country music which I love (tunes by the Stanley Brothers, Louvin Brothers, the Blue Sky Boys, and of course Bill Monroe), I prefer the long scale, the tight crisp tone, the definite volume, and that



Jim Trach records in the log as Ellsworth Bush makes the interior inspection.



Martin repair log.

certain country sound of a Martin Dreadnaught. If money weren't an object, I'd own many different Martins (my dream is to someday custom-order a 12-fret OOO-45). As it is, though, I always seem to settle on a D-18. I like mahogany, I guess.

Martin guitars are set up a little differently than Gibsons. If you're looking at getting into the guitar repair business and you happen to be a Gibson lover, or don't know much about Martins, don't ever set up a Martin like a Gibson (or vice-versa)—you'll lose a customer! Notice that the C.F. Martin factory has several actual "check-points" for jobs which Gibson either does by eye, or has no written measurement for (note also that Martin lists measurements differently than Gibson). Some of the following adjustments, such as bridge pin height, would never be incorrect on a *new* Martin because they're an integral part of final inspection. But you may need to make adjustments on numerous used instruments, especially if they've had a replacement bridge installed by an untrained hand.

Martin Factory Specs

Maximum neck relief at 7th to 9th fret	Factory	Mine
On all strings:	.010"	.005"

String height at 12th fret	Factory
On the bass E string:	3/32"min~ 7/64"max
On the treble E string:	1/16"min~ 5/64"max

String height at the nut	Factory
Measured from the bottom of a string to the top of the first fret.	Bass E: .024"max Treble E: .016"min

Bridge thickness	Factory
	5/15", 11/32" or 3/8"

Bridge saddle protrusion	Factory
	3/32"min~ 3/16"max

Bridge saddle shape

The radius of a Martin bridge saddle is slightly flatter than the fretboard, and the saddle rises gradually in height toward the bass side to eliminate buzzes on the bass strings.

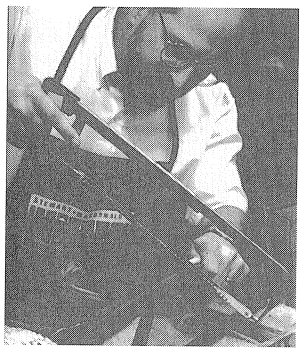
String inset	Factory
Distance between edge of fingerboard and the *outside* of both E strings.	3/32" ± .016"

Bridge pin height

All pins must be a uniform height above the bridge surface, and measured from bottom of the "ring," must be .032"min~.062"max.

String installation

Bass side strings passed throught the string hole with string wound halfway around post under longer portion of string, bent backward over string, and wound counter-clockwise 2-3 wraps around post toward headplate. Follow same spec for treble strings with 3-4 wraps clockwise around the post.



Some modern builders use American Flyer sled runners for T-bar replacement, since Martin's T-bar is no longer available.

OBSERVATIONS (AND OPINIONS) ABOUT MARTIN GUITARS

■ The fretboard radius will vary from 16" to 20". A 16" radius is most common.

■ The action will go lower than the factory specs if the frets are properly levelled.

■ Because of the flatter fretboard radius, Martins may not feel as comfortable as instruments with more arch in the fretboard do when you play chords. However, many players feel that you can get more power without buzzing on a Martin than on a Gibson, because of the flatter board.

■ Models made before 1985 do not have an adjustable truss rod. Certainly the newer Martins with adjustable rods are easier to set up than the old ones. I still prefer the old "T"-bar Martins (pre-1969) for stiffness and tone.

■ Martins seem to need neck resets more often than Gibsons (especially vintage pieces of the same era). Do not try to account for an underset neck by planing the fretboard or whittling down the bridge on vintage instruments!

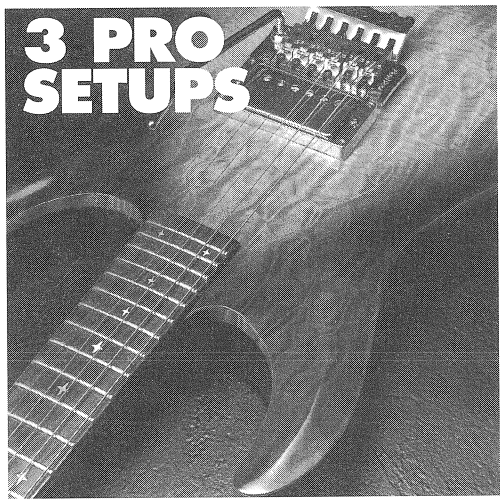
■ Instruments made between 1969 and 1985, with hollow "square tube" truss rods, often develop more up-bow than the older instruments (see the Fretting chapter).

■ A "bellied" top (an arch in the top around the bridge) is not necessarily *bad*. Most flat-top guitars are supposed to have a nice gradual arch in that area since the top is *built* with an arch in it. Do not hasten to "flatten" the top, or let someone talk you into it.

■ A slight "bubble," or rise in the top behind the bridge, and a dip in the front, is not uncommon with Martins. It isn't normally severe enough to warrant serious interior structural work such as bridge pad replacement—but can be in extreme cases. Severe kinks are often caused by loose bracing (especially the X-bracing in the bridge pad area).

■ I think the Martin company is too generous to their customers by offering a lifetime warranty on an object made of wood. Many owners take advantage of the warranty by expecting Martin to repair problems that are caused by nature or neglect. Martin, however, is unfailing about taking care of their customers. Give them a word of thanks sometime—they deserve it!

A final note on setups: With any guitar, electric or acoustic, after all adjustments are made, I will often straighten the neck completely (if it's adjustable) and see how the guitar plays with a straight neck. I generally prefer a straight—or almost straight—neck to one with relief.



Low action and the blues

During all my years spent repairing and setting up guitars, low action without buzzing seems to be what most customers are after (at least electric players). Somehow, electric players get it into their heads that the strings should be close to the frets—*real* close—and they expect this low action without buzzing. Always a blues player, even when blues wasn't as mainstream as it is today, I've tried to convince customers that by having the action a little higher, they could get better bends and more sustain, and make the guitar sing. But often customers would misinterpret this as a cop-out on my part because I couldn't (or wouldn't) give them the low action they thought they should have.

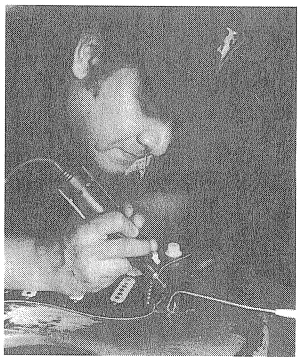
I realize that there are many guitarists whose style requires low action in order to execute certain passages fast enough. And many hot country pickers that *don't* do much string-bending can have a slightly lower action than players that do bend. But more often than not, when you get the rare chance to play a top professional's axe, you'll find the action higher, and the strings stiffer, than you might have guessed. I believe that this is because more players today incorporate blues styles—in particular the singing blues bends made famous by B.B King and Albert King—into their playing. Where would Jeff Beck or Stevie Ray Vaughn's music be without the blues? What made Eric Clapton and Cream famous? How did Hendrix drive crowds wild? With certain traditional jazz guitarists as an exception, I don't know of many great guitarists who can't, and don't, play the blues; and players like Eric Johnson, Vernon Reid, and Steve Morse have taken blues to new heights. None of them are wimps, and neither is their action.

With this in mind, I took advantage of every opportunity to check out the setups of some of the world's great blues players. These interviews ran in *Guitar Player* over a period of several years.

If you can set up a Stratocaster, you can set up any electric guitar—and you don't need a guitar tech to do it for you. Just keep reading!

Stevie Ray Vaughan and Jeff Beck

Great guitarists have the ability to make their instruments talk. Doing so takes a special gift, a lifetime of practice, and a great guitar. Haven't you always hoped that the guitar had *something* to do with it? Wouldn't you guess that a great player's guitar is set up to play really well? If you're like me, you'd like to know just how their guitars are set up (and I don't mean simply with what gauge of strings, or whether the action is high or low). You wonder how *their* guitars might feel in *your* hands. Would you play better?



Rene Martinez using a Dremel Moto-Tool on Stevie Ray Vaughan's Number One.

In November 1989, I had a chance to try out the guitars of Jeff Beck and Stevie Ray Vaughan when these great guitarists played the Ohio Center in Columbus. I was anxious to see how their guitars would measure up to my expectations. Then I decided to do just that—measure them—so that you, too, would have a chance to adjust, set up, and compare the feel of your guitar to those of these top players.

Before the show, I spent the day with Jeff's and Stevie's guitar techs—Geoff Banks from Witley, England, and Rene Martinez of Denton, Texas, respectively. Geoff has worked with Trevor Rabin of Yes, Robert Plant, and most recently Jeff Beck, Phil Collins, and Genesis. Rene honed his skills for years as a repairman for both Charley's Guitars and Zack's Guitars in Dallas. I was interested in the simple but subtle setup and action adjustments—the everyday stuff of being a tech for a guitar mogul. Of course, I was all ears for any other tips, tricks, and secrets Geoff or Rene might divulge. Here's what I found out:

As this book was being completed, we got word of Stevie Ray's death. We've all lost him just as he had come into his own as a major force in the Blues. We miss him.

Jeff and Stevie Ray were traveling with nine guitars, all of them Strats. Jeff's four included a yellow Vintage reissue model made by Fender's George Blanda in '86, as well as three custom-ordered Strat Plus models recently handcrafted and set up by ace guitar man Jay Black of the Fender Custom Shop. The Strat Plus models are equipped with Wilkinson nuts, Lace Sensor pickups, and the American Standard Tremolo, and are actually prototypes of a Jeff Beck Signature Model. One significant change is the size and shape of the neck. Jay Black notes: "Jeff wanted the biggest necks he could get—like baseball bats—so I patterned them after a 1935 Gibson L-5. Each neck is big, but different in size, shape, and feel. The seafoam green one, which Jeff favors, is an inch thick all the way down."

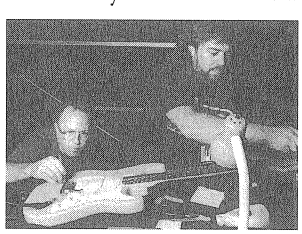
Stevie's guitars are all pre-'63 models, except for "Charley" (outfitted with the Danelectro "lipstick tube" pickups, it was made from kit parts at Charley's Guitar Shop in 1984). They all have names, too: Number One, Red, Butter Scotch, Charley, and Lennie. The only significant change from stock on these Strats has been the addition of 5-way switches and a good coat of shielding paint in the control cavities. Number One, the beat-up sunburst that we all know, is Stevie's main squeeze.

NECK ADJUSTMENT

With all the guitars, neck straightness is the first thing I checked, sighting down the fingerboard. A fingerboard should either be dead-flat or have a slight up-bow, known as relief, in the direction of the strings' pull. Stevie's guitar had approximately .012" of relief around the 7th and 9th frets, and then leveled out for the remainder of the board. Jeff's fingerboards are flat—adjusted straight as an arrow. Jay Black said, "I gave them a *little* relief, but .007" at the 7th fret would have been generous."

STRING GAUGE

Stevie tunes his guitar to *Eb* and uses GHS Nickel Rockers measuring .013, .015, .019 (plain), .028, .038, and .058. On this particular day, Rene had substituted an .011 for the high-*E* to keep down the sore fingers that blues bends can cause. Jeff performs his acrobatics exclusively on an Ernie Ball set gauged .009, .011, .016 (plain), .026, .036, .046. Both Geoff and Rene change strings every show for each guitar that gets played.



Geoff Banks strings up Jeff Beck's Strat while Dan takes measurements at the bridge.

FRETWIRE

If you're trying to evaluate action, it's nice to know what size and shape of fretwire is used. Number One's frets measure .110" wide by .047" tall. These frets would have started out at .055" tall when they were new, and were probably either Dunlop 6100 or Stewart-MacDonald 150 wire. Jeff Beck's frets aren't quite as big. According to Geoff Banks: "Jeff went with the Custom Shop's recommendation of a .098" wide by .050" tall fret. This is what Fender now makes as a 'vintage' wire, although it's taller than the wire used in the '50s and early '60s."

STRING HEIGHT

I measured the distance from the underside of the strings to the top of the fret at the 12th fret on both *E* strings. Rene Martinez describes, "I set up all of Stevie's the same: 5/64" on the treble *E* string and 7/64" at the bass *E*." Geoff Banks: "Actually, I don't measure them. I do it by feel, and what I know Jeff likes." (I measured slightly over 3/64" on the treble side, and 5/64" on the bass. Later, Jay Black told me: "I set them up at 3/64" [treble] and 4/64" [bass], but I did this with the string fretted at the 1st fret; I like to eliminate the nut when making this measurement."

FINGERBOARD RADIUS

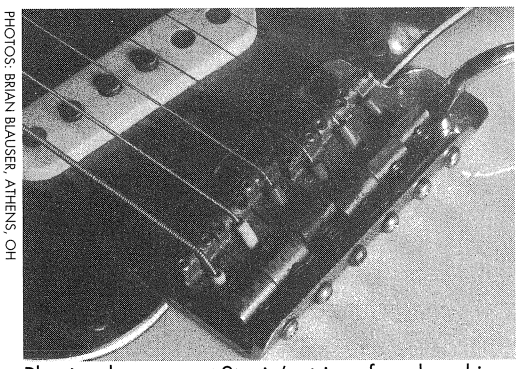
Knowing the fingerboard's radius can help in setting up a comfortable bridge saddle height and curve. Stevie's Number One was somewhat flatter than the vintage 7¼" radius. Rene has refretted the neck at least twice, and in the process the fingerboard has *evolved* into a 9" or 10" radius in the upper register. This isn't the result of a purposeful attempt to create a compound radius, which allows string-bending with less noting-out; it just happened. Jeff's custom Strats have a compound radius, too, starting out with Fender's currently popular 9½" radius, but flattening out further on up the board. Jay Black hand-shaped them, and from about the 12th fret up they flatten out to an 11" radius.

BRIDGE SADDLES

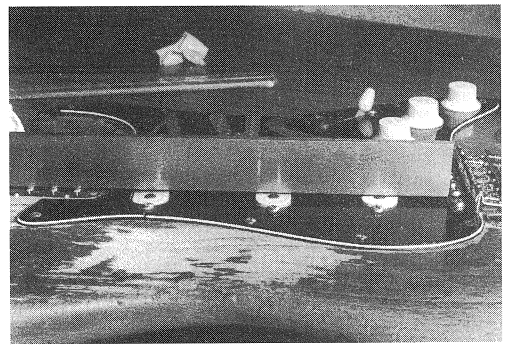
The bridge saddles on Jeff's green custom Strat Plus were set at the Fender Custom Shop to the same 9½" radius as the fingerboard. The new-style Fender saddles are formed with a smooth groove to follow the string angle and support it gradually up to the point where the string takes off at the saddle's peak. While these saddles aren't overly prone to string-breaking, Jeff did manage to break a *D* and high-*E* string or two later that night. This was more a result of his exuberant attack, though, than evidence of any bridge saddle troubles.

Stevie's Number One, however, wants to break high-*E* and *B* strings at the saddle every chance she gets. Rene showed me why the strings break, and how he takes care of the problem: As a string comes out of the vintage Strat tremolo block/bridge top plate, it "breaks over"—or contacts—the metal directly; this causes a slight kink that weakens the string.

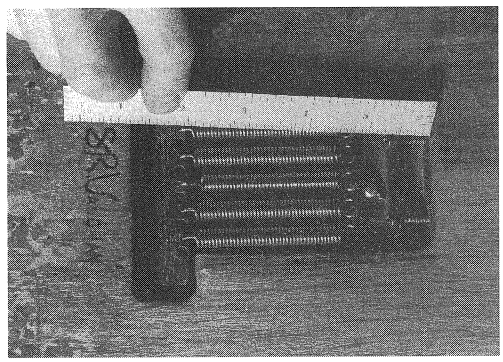
PHOTOS: BRIAN BLAUSER, ATHENS, OH



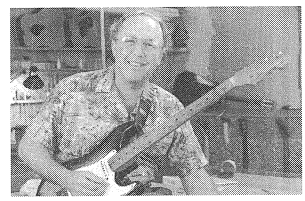
Plastic tubes protect Stevie's strings from breaking.



Stevie's polepieces are highest on the bridge side.



His standard vintage tremolo uses all five springs.



No other guitar—not even the Les Paul—has been so popular for so long. I've been fixing the darn things for almost thirty years!

With the bridge saddles removed, Rene uses a Dremel Moto-Tool to grind the hole's edge until the lip is smooth and gradual, and any binding is eliminated.

Number One uses vintage replacement saddles (the originals wore out long ago), and they're not all alike—some have a shorter string slot than others. The high-*E* and *B* strings may contact the front edge of this string clearance slot as they rise toward the takeoff point at the saddle's peak. The kink formed by the contact stretches onto the saddle peak during tuning and breaks right at the crown. Rene elongates the slot, again by grinding, and then smooths any rough metal edges. Finally, he slides a 5/8"-long piece of plastic tubing (insulation from electrical wire) over each string to protect it from the metal break points. He uses the heaviest piece of tubing that still fits down into the tremolo block hole. Even with this, the high strings still cut through the plastic quickly, and strings break—sometimes in only one set. Rene plans to try a Teflon wire insulation if he can find the right size.

NUTS

Jeff's Vintage reissue has a standard Fender-style nut. The three custom Strats are set up with Fender/Wilkinson roller nuts, like those used on the Strat Plus. Stevie's Number One, Lennie, and Charley have standard Fender-style nuts, but Rene makes them from bone. Stevie prefers the sound of bone, although for studio work he had Rene make brass nuts for Scotch and Red.

TREMOLO SETUP

Measured at the rear of the tremolo plate, Jeff's American Standard Tremolo shows a healthy 3/16" between the bottom of the plate and the guitar top. He uses three tremolo springs mounted in the two outer and one center hole in the tremolo block. The springs connect to the middle three fingers of the claw and are tensioned so that when he plays, say, the 3rd fret of the *D* string, it provides one whole-step if the bar is pulled up until it stops. His standard Vintage tremolo is mounted with all six screws and uses all five springs. It's tensioned so that the plate returns flat onto the top; I measured 7/16" between the spring claw and the cavity wall where the claw is attached.

Rene prefers the durability of the stainless-steel Fender tremolo bars. He puts a small wad of cotton at the bottom of the tremolo block hole to keep the bar from over-tightening and becoming hard to remove if it breaks. He emphasizes the importance of lubricating all the moving parts of the tremolo system, preferring a powdered graphite-and-grease mixture (the grease holds the graphite in place where it's needed). He lubricates everything that moves: mounting screws/plate, all string breaks and contact points (including the saddle peaks) where the springs attach to the block and claw, the nut slots, and the string trees. Many other lubricants work: Vaseline, Magik Guitar Lube, Tef-Lube, etc.

PICKUP HEIGHT

As a reference point, I laid a precision steel straightedge along the frets for making this measurement. Jeff's Lace Sensors have little magnetic string pull, and therefore can be set quite close to the strings; in fact, they work best that way. On the treble side, the pickups were all within 3/64" of the straightedge; on the bass side, they touched it.

Stevie's pickups were raised fairly high. I measured from the straightedge to the pole-piece tops: On the treble side, the bridge pickup touched the straightedge, the middle *almost* touched the straightedge, and the neck pickup was 1/16" away. The bass side measured 1/32" at the bridge pickup, 1/16" at the middle, and 1/32" at the neck.

TUNING MACHINES

We've covered about everything except tuners, and there's nothing secret here. Except for the yellow Vintage reissue, Jeff's Strats are equipped with either Sperzel or Schaller rear-locking tuners. Stevie Ray's tuners are the originals, and each has three full string winds for the best angle at the nut.

Well, that's the end of this story. You'll need an accurate 6" ruler to do the set-ups, and you can get one at any hardware store (General makes a good one). Don't be surprised if you go through a few sets of strings while you experiment. Good luck, and I thank Geoff and Rene for all of us! I had a lot of fun gathering this information, to say the least, and I hope you find it useful.

Setting up for slide: the Mooney innovations

If you're into slide but have never heard John Mooney, catch his act if he comes anywhere near your town. One of the few guitarists to master the true feeling of Delta slide guitar, the "Moonman" comes mighty close to capturing the Robert Johnson sound. John spent his late teens and early twenties learning firsthand from Son House. Now, after living in New Orleans for 15 years, he plays "second line blues," combining the best of the Delta style with the infectious rumba boogie and funk rhythms made famous by Professor Longhair and the Meters.

Recently John Mooney's Bluesiana (David Lee Watson on bass, Herman V. Ernest III on drums) visited Athens, Ohio, on their way to do the *Mountain Stage* radio show. I found that when it comes to guitars, John's a skilled do-it-yourselfer with some revolutionary ideas concerning slide setups for Strats. I wouldn't suggest these modifications for a vintage piece, but for newer Strats or the many copies, you could have some fun.

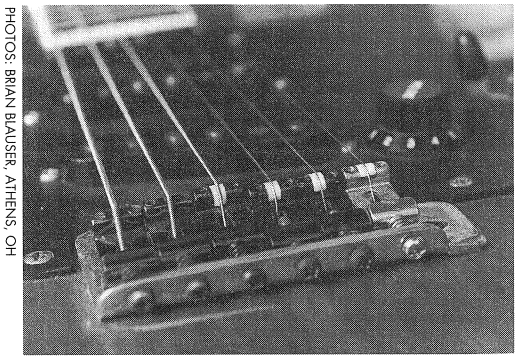
Onstage John uses two early-'50s National wood-bodied electric arch-tops, as well as two real Fender Strats (a white '65 and a seafoam-green '62 vintage reissue) and three extremely high-quality Japanese copies made by Artex. The Nationals have *great* tone, but at certain volumes they feed back too much (unusable feedback, that is, since John points out that some feedback is good for electric slide). He started using Strats because they're easy to travel with, they can take a beating, they make a great blues guitar, and they don't feed back.

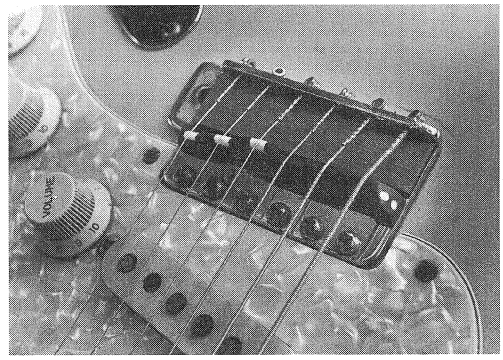
Except for the '65, John has dramatically customized his standard vintage tremolo bridges. Using wood, bone, and fossil ivory, he either alters the metal bridge saddles or replaces them entirely. "The *typical* Strat sound is not what I'm after," he says. "Strats, with their metal bridge saddles, are just too tinny. There's not enough tone generated by the slide. I like a more woody sound. By using different combinations of wood and bone at the bridge saddle, I capture enough of the National tone to keep me happy. A wood bridge adds warmth and a physical presence to the strings' vibration that interacts with the slide to give the response and tone that I need."

John Mooney

■ One alteration is the filing of square "holes" through four of the metal saddles, into which hand-carved bone inserts are super-glued. John uses this setup on his standard-tuned Artex.

PHOTOS: BRIAN BLAUSER, ATHENS, OH





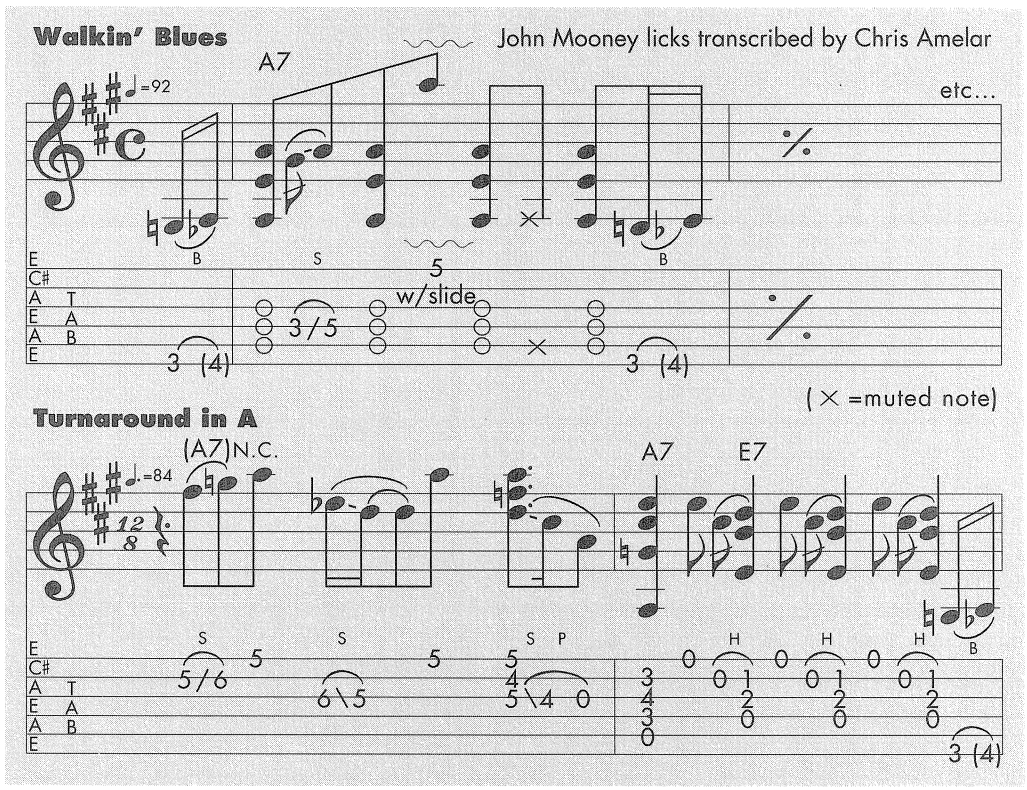
■ The complete bridge "overhaul" involves entirely replacing the metal saddles, springs, and adjustment screws with a handmade, compensated wood bridge (some ebony, some rosewood) to mellow out the treble. Mooney describes, "The ebony or rosewood bridge saddles removed too much brightness from the treble strings, so I capped the saddle with bone inserts super-glued under the *E*, *B*, and *G* strings to balance the brightness. When I make these wood bridges, there are no adjustment screws to save me if the bridge saddle height gets too low—it won't go back up. So I lower the action slowly, stopping at various stages to play it for a couple of days, until it's just right. Then I set the intonation. I fret notes too, so it's not like playing certain lap-steel styles where the strings never contact a fret and

the fretted intonation is less important. "You'll notice that when I replace the standard metal saddles, I restring through the bridge plate holes that previously held the saddle's six length-adjusting screws. Stringing up through the tremolo block in normal fashion creates such a steep angle that the wood saddle would slide forward or fall over. This creates a different sound than stringing through the tremolo block, but I like it.

"At first I tried using wood arch-top bridges on the Strat. I'd use the top saddle part, cut off the ends, and shorten the height. But with my high, stiff action, I had a rough time getting these 'store bought' compensated wood bridges to play in tune—the saddle peaks reach correct intonation in a different spot. Now I'm carving my own, which is better. With heavy strings and the high pitch of open-*E* or open-*A* tuning, you get a good, strong note when you compare the 12th fret octave to the harmonic—it's much easier to hear than a low-action, light-stringed ax. I carve the saddle peaks close to the right intonation by ear, super-glue the bridge in place, then finish up using a tuner to tell me where to remove wood with a file."

Mooney further "Deltarizes" his Strats by chiseling an increased "sound chamber" into the body wood under the pickguard and installing a solid mahogany pickguard. "I hear a big difference in sound with the solid mahogany pickguards," he notes. "Even acoustically, the sound is great." John's first Strat, a '63, had no pickups when he got it, so he chiseled the body out to accept a pickup from an old Present Company brand guitar. "I was a kid, you know, and I just wanted it to work. Later I put a mahogany pickguard on it, a Tele pickup at the neck, and a humbucker at the bridge—more chiseling. It sounded great! I realize now that part of the sound I liked was from the body being routed, so I'm trying to recapture that sound that I remember from a long time ago. I don't remove a lot of wood, but it makes a difference. The Artex factory routed out the two most recent guitars after they'd seen the one I chiseled out, but they took out a little too much, so I've been filling them back in with scraps of wood."

John keeps six guitars onstage in order to have a pair each in standard tuning, open *A*, and open *E*. He sometimes brings a seventh along for *G* or *D* tuning as well: "I like to sing in *G* and *D*, but I prefer playing with the higher



I couldnt resist giving you this! This is John Mooney showing how it's done: a little bit of bona fide delta sound. It's worth your time to mess with these two examples. "Walkin' Blues" is the original Son House version!

tension of the *A* and *E* tunings. So I only use *G* on four or five songs a night. I use specific gits for specific songs, because they sound and play different in different keys. If you play in five tunings and only have one or two guitars, you'll be tuning up all night. Besides, a guitar properly set up for open-*A* tuning won't play just right if you drop it to open *G*. And the string gauges are a little different for each tuning." John uses bronze-wound D'Addario mediums or GHS Boomers. For open-*G* tuning, his gauges are .016, .018, .024 (plain), .034, .046, .059. For open *A* or open *E*, he uses .016, .018, .024 (plain), .032, .044, .058. Guitars tuned standard are strung .013, .016, .019 or .020, .030, .044, .058.

All of John's guitars have a bridge saddle radius that's quite flat (ranging from 14" to 20"), even on the 7¼" vintage radiused Strats. To get good contact from one string to another with the slide (especially on the treble strings), he flattens the radius on the treble strings by putting the high-*B* string at almost the same height as the *G* string and the high *E* as tall as the *B*, so it's not as round as the fretboard radius would dictate. He flattens the bass side a little too. "The National steel has a fairly flat fretboard radius—about a 16"—and that's what I'm used to. So setting the high-*E* and *B* strings a little higher than the radius calls for lets me hit them really hard and get better tone. And using a .016 for an *E*, you can really lay into some stuff. I think Bob Brozman uses an .018! The .016 works good for me. Even on my standard guitars, I set the high *E* up a bit because I hit it so hard." Mooney's fretboard/bridge radius combinations on the National arch-tops are 10" board, 14" bridge. On the Fender Strats, it's 7¼" board, 12" bridge. The Artex have a 16" board, 20" bridge.

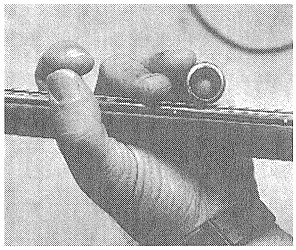
All of John's necks have some relief, and he sets up his standard-tuned guitars a little lower than the sliders: "When you tune up to *A* or *E* tuning with fairly heavy strings," he points out, "the truss rod really has to work to keep the neck straight. In time, a neck can even take a 'set' from the string pressure—they all pull up into at *least* .010" of relief, and sometimes as much as .018". That extra up-bow gives good clearance in the middle of the fretboard for slide playing, without your accidentally fretting the string with the slide."

John's string height wasn't as high as I would have guessed, considering his clean tone. His heavy strings and high tunings create lots of tension. Measuring the gap between the string bottoms and the top of the 12th fret, I found that all of John's guitars measure about ⅛", give or take 1/64" in either direction. The National arch-tops are set the highest because they have the same 24¾" "short" scale as many Gibsons (Les Paul, 335, J-45, etc.), so their string tension isn't as stiff as the longer-scale Strats, which measure 25½". John sets them up higher to make up for their lower tension. "Since I do most of my slide work on the treble strings," he adds, "I set the treble strings on the Nationals higher than the bass. Scale length makes quite a difference in string tension." Mooney's nut is another reason his slide sound is so clean: "I like a good stiff nut height for slide playing—around 3/64" clearance between the string bottoms and the top of the 1st fret all the way across."

Mooney points out that since his playing style evolved on the National steel, he tries to recreate the National's action (and in many ways its sound) when he sets up an electric—the Delta sound is in his blood. He doesn't travel with the National because it's hard to amplify and doesn't take a beating as well as the others. He did have it along on this trip, however, and it looked like it sure had taken a beating—especially the wooden bridge saddle. John describes a repair he often performs: "With some National steels, it's common for the low *E* in particular to pop out of the bridge saddle slot. You can super-glue match sticks on top of the wood saddles to hold the strings and keep them from popping out. Several have broken loose and need to be replaced. Got any super glue?" (Are you kidding?)

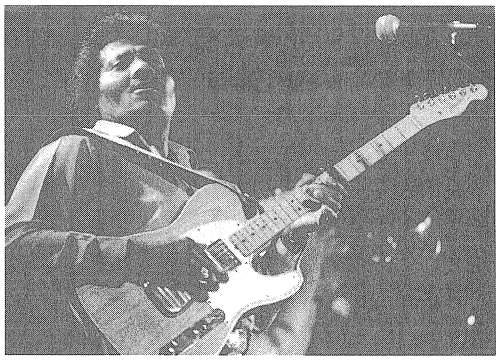
Mooney keeps his white '65 Strat tuned standard. "This is the least-customized of all my guitars," he explains, "and it has the only stock Strat bridge. I wired the pickup selector switch backwards, because I hit it when I play. That way, since I almost always use either the neck or neck/middle combination, I can just leave the switch pushed down out of the way of my picking hand. I've also raised the *B* string's

polepiece by pushing it up from the bottom. It'll move about a 1/16", and I set it even with the high-*E* polepiece. I need that extra power on the *B* string to keep up with the higher-pitched .016" *E* string." Please note: *This is not a good idea!* It will work, but it may just as easily cause the pickup to quit working entirely. It's better to have custom-made pickups with the pole-piece set this way.



For his slide, the Moonman uses a piece of brass pipe that came out of an old house in New Orleans. "It's different than the brass you can buy today—it's pitted, and the texture reacts to the string differently than smooth brass. Like Son House, I put the slide over the first two joints of my pinky. It just goes to the second knuckle. See, a big part of Son's slide style was damping the strings behind the slide."

Albert Collins: talking guitar with the Iceman



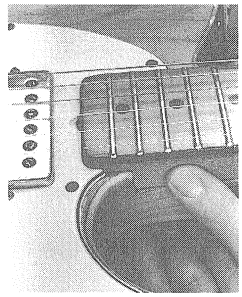
PHOTOS: BRIAN BLAUSER, ATHENS, OH

Albert Collins' unique Texas swing blues guitar is refreshingly different from Chicago blues. Albert's "simple" style, brilliant tone, and organ-like phrasing have earned him the title Master of the Telecaster and made his patented licks a part of any blues player's arsenal—from Robert Cray to the late Stevie Ray. As his many recordings and live concerts show, Albert is a strong vocalist and killer showman, so don't ever miss him if he plays near you!

Albert's bus broke down as he pulled into the Columbus, Ohio, hotel parking lot. He drives his own bus and sometimes fixes it too, so my first in-person glimpse of the Iceman was of his black leather coat, pants, and boots sticking out from under his vintage Greyhound tour bus!

Who takes care of your guitars?

I take care of my own. There's only two, my original Telecaster and the new model Fender made for me, which is a copy of the old one. Changing strings, cleaning, or little stuff—it doesn't need much. Oh, sometimes my little *E* will rattle, stuff like that, and I'll adjust it at the bridge with the little Allen wrenches.



You've had some heavy-duty work done on your fretboard, including having a 3/16" maple "cap" laminated over the worn neck from the end of the fretboard all the way to the 3rd fret.

That was done by Guitars R Us, which is down the street from the Guitar Center in L.A. But now the stuff on it—the neck finish—makes my hand break out with a fungus. It doesn't do it with my right hand, but it makes me break out on the left one. I guess it's from the type of finish used. It's been happening quite a while now.

Do you carry any special guitar tools?

Allen wrenches and stuff like that, in case one of my screws comes loose. Or I used to have the problem of where you plug it in at the input jack, and it would fall out all the time. The whole jack would fall out, so Guitars R Us fixed that for me.

Do you set up your own action and intonation?

Not too much. I just take it to a guitar tech—somebody who can work on it.

You must have had problems over the years with fret wear and buzzing. Do you ever adjust your own neck?

I don't ever really have that problem very much with my guitar. And the humbucking pickup was already on it when I bought it used in '68 or '69—it's a 1961 Telecaster. The first time I heard a humbucker in a Tele was on the one I got now—I liked it, and I got it.

Those big frets on it weren't available in '69. What made you choose them?

I wanted the big ones since I saw Stevie Ray—he had a guitar with the big frets on it. Stevie said, "Put some of them on there—it'll last longer," so I had them put in there in '82. And he was right. I used to wear them little small frets out. They didn't last me no time— I'd just keep wearing 'em down. You know, I used to put 'em in myself a long time ago!

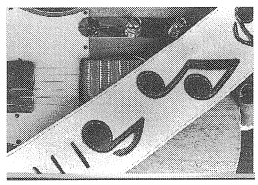
No kidding! You did your own refrets?

Mm hmm. I'd go buy my frets, they'd give me the stuff to put 'em in, and I'd set it like I want it. That was on a '59 Tele—that's the one that got stole from me when I first got to California. Yeah, I miss that one. I refretted it two times through the years. I'd just go down to Parker Music Company in Houston where I lived—I'm really fond of Houston—and he'd say, "If you leave the guitar, man, you can have it back in two or three weeks." I'd say, "No, I'll do it myself. I can't wait so long—I gotta play!" He gave me all the stuff [tools] to do it with. He basically told me what to do. I didn't have no problem.

During the past 10 years, have you had the big frets worked on?

Nope. I've just had the guitar strobe-tuned, and that's all. Nothin' on the frets. And I used to take the necks off. When I first started playing, it was on an Esquire; I couldn't afford a Telecaster. So I went and bought a Telecaster neck and put it on an Esquire. I did that myself too.

How does your old Tele—the famous one—feel to you these days?



It feels pretty good, but I want to redo it again just to make it look a little better. It's pretty worn in places.

How does your new Albert Collins model compare with the old Tele?

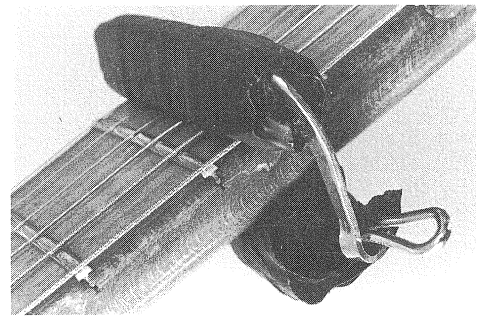
I need to break in the new one, and it'll be fine. Like all guitars, even though it's a copy, it's still different. I don't say better or worse—just different. I had both my guitars weighed, and the new one is heavier. Since that time the actual production Albert Collins model has been lightened to match the original.

Do you break strings very often?

Every now and then I break 'em when I get, like, a sweat on. So I change strings twice a week if I'm playing six nights. I'll break two strings at once sometimes—at the bridge, the middle of the neck—it don't make no difference. I break my little *E* string the most.

Can you recommend a brand of string?

Well, I've been playing the Fender Rock 'N Roll 150 set a long time. I use .010, .013, .015, .026, 032, .038. I used to play the Black Diamond strings. Man, they were so thick they used to make my fingers bleed. I've tried a .009, and I can't use them; they're too light for me. [*Albert tunes to an* Fm *triad:* F, C, F, Ab, C, F, *low to high. He often capos.*]



Your high tuning and use of a capo must make it tough to bend strings.

Sure. My hand sometimes gets so sore I can't hardly touch them strings, but you gotta play anyway. We used to get that stuff you call "new skin" [mole skin] and put it on there. But sometimes it would take the feeling out of my fingertip—I couldn't feel it like I wanted to. Before I left home we hadn't been playing that much in about a year, and then we'd be playing every night. Them strings will make you real sore until you get tough.

Which pickup position do you use the most?

Most of the time I'm in the middle. Sometimes I will use the bridge position for a real hard sound. But I get the hard sound in the middle because I use my fingers—not a pick.

Do you have many other guitars?

I got a '67 at home—I don't carry it now here—but I'm gonna take it out next time and try it. It doesn't have the humbucker, but it could make a good sound.

Why is your sound called Texas swing blues?

They call it Texas swing blues because I use a horn section—it's just different than in Chicago, where the guys from Mississippi would migrate up. We didn't have no harp players or slide guitar players come out of Texas. I was raised up with [saxman] Illinois Jacquet and others. Where I come from, the bigger the band, the

better it is—that's just the way it was. At one time I had nine pieces, and I carried that for about two years. But some of my favorite guys didn't work with a big band. Lightnin' Hopkins was a cousin of mine, so I was around him more than anybody. I remember when him and Little Sonny Jackson used to run around together, and I think they did some time together in prison. Lightnin' used to live in Dallas, and he was the only legend I ever knew well.

VITAL STATISTICS

- String gauge: Albert says he uses Fender strings gauged .010-.038, but the strings I measured read: .009, .011, .013, .025, .031, .037. It seems strings never measure out to be exactly what the package says, so it's a good idea to own a pair of dial calipers to measure different brands.
- Neck width: 1.553" at the nut, 1.920" at the 12th fret.
- Fret size/height: Approximately 108" wide by .047" tall—probably a Dunlop 6100 or Stewart-MacDonald 150 fretwire worn down from the normal .055" height.
- Pickup height (measured from the top of the pickups to the bottom of a straightedge laid on the frets, with the guitar in playing position):

Pickup	Bass Side	Treble Side
Neck	1/16"	3/64"
Bridge	1/32"	1/32"

- Nut height/string clearance (with the guitar in the playing position, measured from the bottom of the string to top of the 1st fret): The clearance between the bottom of the outer *E* strings and the top of the 1st fret for both guitars was .010" under the high *E*, .022" under the low *E*.
- Neck relief (measured at the 7th and 8th frets with guitar in the playing position and a long straightedge laying on the frets): .003"—quite a straight neck!
- String height at the 12th fret (bottom of outside *E* strings to the top of the 12th fret): Medium-low action measuring 5/64" at the low *E*, graduating to a little more than 3/64" under the high *E*.
- String width at the nut (measured with dial calipers from the outside *E* to *E*): approximately 1.281" to 1.310".

Buddy Guy: my guitar is almost like my love

Ever since his first road trip in 1968, when he played out of this world on a '57 Stratocaster, Buddy Guy has been inspiring Strat players everywhere. These days his tone is better than ever, and there's arguably no finer blues player alive than Buddy Guy. We met to talk guitars, and then I took the setup measurements of Buddy's signature-series Fender Stratocaster and his trusty Guild Nightingale.

How does your Strat feel right now?

It feels great. My guitar's almost like my love.

Is the Buddy Guy model the only Strat you play these days?

No, no, no. Now they just sent me another one they made—the Stevie Ray Vaughan model. But I want to go back to as close as they can get to the original sound that those guitars had when Leo [Fender] first made them.

How do those Lace-Sensor pickups compare to the ones on your old Strat?

I don't have no choice. Let's put it like this: If you had an accident in a car now, would you rather have it in one of these new ones or one made in 1940? Because you could bump in 1940, and you wouldn't dent it. All that was stone chrome on those cars back like that. So there's just no comparison to that. I think it's the same thing with amps, but they did do pretty well with this new reissue of the Fender Bassman. And they're doing a *tremendous* job with the Fender guitar, but I don't think you'll ever compare to the old sound. I don't want to put the scam out on nobody, but when Fender went haywire there in the '60s and went out of hand, I think it was a rat-race for the *look* of the guitar—not the sound. They come out with all the different pretty colors and was just settlin' for the color.

Why don't you just put the old-style pickups in your guitar?

I don't have them! You can't find 'em. They can make the new one look like the old one,

PHOTO: BRIAN BLAUSER, ATHENS, OH

but it's not there. The engineers and everybody else know it's not there.

Do you work on your own guitars?

No, the only time I work on them is when I hook them son-of-a-bitches up—any other way, no. Oh, sometime if I have to adjust something on it, I know how to do that, but I won't fool with the neck or nothin' like that. But the bridge I would—especially on the Strat. Sometimes I have to fool with that. I never learned that much about fixing it. I put most of my time on learnin' how to *play* it better—each and every day, as I still do now. And when it needs some work I'd rather send it to someone else while I hold the other one in my hand and try to learn. If I knew how to play like B.B., I probably *would* learn some technique about adjusting and so on. About the worst thing I *will* do is the height of my strings. Sometimes I think I play them too low, 'cause I like to play with one hand, and the lower they are, the more you can get out of one hand. So that's the quickness and the snap that gets me to the frets. You snap, and it notes more clearly like that.

The Strat you used early in your career only had a 3-way switch, whereas Fender later decided to go with a 5-way switch.

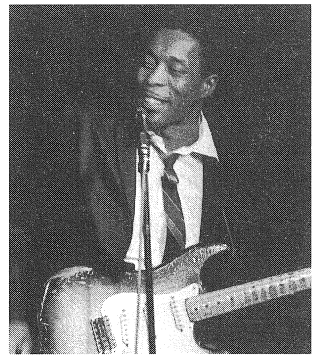
No, no, no. *We* finally set that switch in between those two things and got that sound. *Then* they heard about it and came up makin' that switch like that. When they first come out, it's like you said, they had a switch for each pickup. Then we found that sound in between both of them [*two pickups wired in parallel*]. And that got back to Leo or somebody, so they decided to make that switch many years later. Now all of 'em got it made on the switches.

So on your old Strat, you used the in-between position?

A lot, a lot. Towards the front—between the front and the second pickup. That's what I was usin' when I went into Chess and started playin' a lot of sessions with Muddy and the rest of them. And that's what sound I used on the *A Man And The Blues* album. That was on my original Strat—the vintage which they call it.

Do you know what year that Strat was made?

I borrowed the money to buy that in '58, so I'm sure it was a '57 or a '56—at that time I don't think they was even keeping up with the years on the guitar. They kept up with the years on a car, but guitars wasn't as famous.



PHOTOS: AL BIXT, ANN ARBOR, MI

Buddy Guy in Michigan, 1968

But all of a sudden all the numbers and things started comin' out on guitar and things like that. When I first knew anything about a guitar, all that there was was a cutaway Fender. And I only knew two that was there—a Telecaster and a Strat. And then later on in the years they started doing the guitar like they do the automobiles. But I never go into that with a guitar because that number don't mean nothing to me if the guitar don't sound right.

Do you favor your shorter-scale Guild for a certain sound?

Ah, yes, when I want to sound more like B.B. And I got quite a few of those Guilds. When I first got one, B.B. came in and said, "I heard you got a Lucille." He came back in the dressing room and played it, and I just kept that with me at all times. And now, if I really want to imitate B.B. as *much* as I can, I'd have to go get that guitar. It's impossible to imitate him, but I do the best I can. That guy deserves way much more than he's gotten credit for. He's doing okay, but I think B.B. should be as well known

as Eric or Beck or anybody like that, man, because we all playing his licks. Nobody was squeezing that string until he came out. Then I got it, somebody heard it from me, and it just went on and on.

Do you keep in touch with each other?

Of course. I still got a key to his house in Vegas; I never took advantage of that, though. He can have mine, too! He can go in my house any time he gets ready. If I'm not there, he can go on and go to sleep. I'd tell my wife get out of the bedroom and leave him alone. Let him have the master bedroom.

Speaking of B.B., is it easier to bend strings on the Guild because of the short scale?

They are easier to bend on the Guild, and I guess that could be why. Because that's my style of playing, bendin'. I break more strings, I think, than any guitar player I know.

You break them on the Guild?

I break 'em on *anything*, if you give me time out there. Because I figure if you don't break 'em, you're not playing 'em. But I do feel embarrassed when I break too many in one night, and sometimes I do. I use a light string, and that even makes it worse. But if I get to the point where I'm making people happy, I don't care. Then I get a smile. I'm fortunate now to have enough guitars out there to not hold up the show, and I got a great guitarist with me, Scott Holt from Tennessee, so if I break 'em all, he can make you forget I'm gone!

Which string do you break the most?

The first one. And I break 'em everywhere, even the middle of the string. Sometimes I get to bendin' on a string, and I just don't have no end. I just don't think it should stop being bent. That's the feeling I get. I think I read somewhere where Eric made a crack where I was bendin' whatever's in it out of it [*laughs*]. I know I like to see the first and the last string touch one another sometimes.

As you bend, do you slide your fingernail under the neighboring string?

Aaah, no. Well, actually I don't even know, man. If it comes under, it's alright; if it comes over, it's alright. You know, I'm not a technical guitar player. I make a lot of mistakes. But when I do make a mistake, I try to come out of a mistake on time. I make a lot of mistakes, because I never go home and practice. I don't think I could sit down and practice. I just go on the stage, and it comes to me and says, "Let's go, go, go, go." Like a rubber band—you stretch and stretch, and you know sooner or later it's gonna break.

Can you recommend a string gauge?

Yes, I'm an endorser for Ernie Ball, and normally I use a .010 or .011 on the number-one string, but on *Damn Right I've Got The Blues* my first string was like .015, which is a big one. I was trying to not break a string if I got a good solo while cuttin' the album. You know, a lot of times you get a groove making an album, and if it's good you may not never get another one that big, because everybody gets too tense. They say, "Oh, we can do it better, we can do it better," but it looks like it gets worse, worse, worse. So by using the heavier strings, I was making sure of not breaking any. Stevie Ray Vaughan played a heavy string tuned down; Hendrix did too. They both tuned to *Eb*. And Stevie's guitar felt like barbed wire, like it was strung with hay wire. Strong hands—oh man, I don't know what that guy had in his hands. But like I was saying, on that album I used a heavier string, and I tuned down the guitar too for recording—first time. I said, "If they gonna tune to *Eb*, then *I'm* goin' all the way to *D*—which I did.

Have you got many guitars at home?

I got every guitar I ever had in my life at home, except the ones that got ripped off.

Do you have any old Strats like the one you used to play?

No, those the ones they go after most. If they would break in the house and see the ones that's *not* Strats, I guess they'd say, "I can't get rid of that one" and don't take 'em. The Strats I got now is the ones they just made—an Eric Clapton, a Stevie Ray, and mine, the Buddy Guy. And I got another one from the '70s. The Buddy Guy model has got the same pickups that Eric's been using—that's the pickup that use the battery, which is fine.

Is the Strat your main guitar?

I favor the Strat because I went into Chicago with it, so I guess I made my little name with it. Plus, I'm not a guitar player of B.B. King's caliber. I was always a wild man with my guitar, and a lot of times when you play like that, the guitar has to be rough. And a hollowbody guitar is not rough. If you drop it in the wrong place, you through for the night—and I couldn't afford two guitars. So I said, "Give me the one that if I accidentally drop it off my neck, I won't break the neck off." I may break a string, a volume knob, or something, and I can replace that. But it'd be hard for me to replace the guitar. So I went after the Strat, and I've had it fly off the top of a car going 80 miles an hour in Africa. The case bust open, it fell out, and I went back and there wasn't but one key out of tune. If I'd have had a hollowbody, I wouldn't have seen anything but splinters on that highway.

How do you prefer your action?

Low, low on the Strat. Sometimes I think I keep 'em *too* low, but that's good for the one-hand playing. But the Guild has a higher action—on purpose.

Do you have any acoustic guitars?

Yeah, they gonna make me play it on my next outing. I got a Guild. You didn't hear the new album *Alone And Acoustic* [Alligator]? There's no band, and I'm playin' 12-string acoustic and singing with Junior Wells. I don't even have the album—I haven't heard it—but it's out there, and it's doing pretty well. Man, I cut it over 10 years ago, and they just released it this November.

What's the extent of your record collection?

I had more than I got now. My kids started going up there, and I started missing records. Then after you get pretty well known, friends come by and tell you, "You don't need it because you can sing it when you get ready." So a lot of my records disappeared like that—which I've changed now, because I'm back into collecting records. A lot of jazz, a lot of piano playing. I love great old piano players. I don't just listen to guitar players. When Bill Doggett's "Honky Tonk" came out, man, the horn solos was like, "I gotta learn that." And I recommend to all guitar players: If you get hung up on just guitar players, you've missed something. I like to play piano solos, harmonica solos—if I can—and whatever. Don't ever get to a point where you just gotta be a guitar player. You hear something, go try to play that note and sound as much as like that as you can. And who *wouldn't* want to sound like the late Little Walter, man—oohhh!

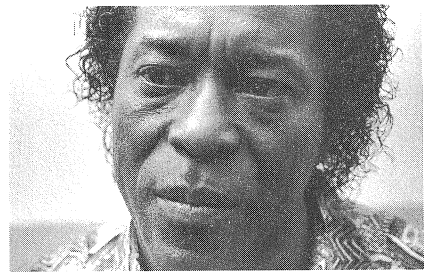


PHOTO: BRIAN BLAUSER, ATHENS, OH

Were you ever tempted to play slide?

I came to Chicago with a slide because I wanted to really do like Muddy Waters. And before I got a chance to get to know anybody, Earl Hooker shows up with this slide, and I gave him mine. On Muddy Water's boxed set, if you search through there you'll find a cut with Hooker on it—somethin' about the birds singing—and I've never heard anybody take a slide and do that before in my life. I didn't want to even attempt at the slide after Earl, so I gave it to him. Every song that came out of the Top 10, whether it was country-western or what, and he could play the melody with a slide. And he didn't tune his guitar like a lot of slide people do—cross-tune to where it'd slide just right—he played everything in the regular tuning.

Do you ever use open tunings?

No, I don't even know how to tune it like that. I know how to drop my low string down to just an open *D*, but I can't play the open stuff like Bonnie Raitt and them do.

What amp did you record with in the early days?

I always had the Fender Bassman, except when I recorded at Cobra [in the late '50s], I didn't have no Fender amp. I went there with a Gibson with four 10s in it. I forget the name of it now, but I loaned that to a friend of mine and that disappeared. Damn near everything I had disappeared in Chicago, because being from the South I didn't know nothing about stealin' and takin'—but I learned that will happen to you in Chicago, because just about everything I went there with come up missing from me because I was kindhearted. I would loan it to people like the late Earl Hooker, the late Bobby King, and a lot of great guitar

players at that time which didn't have guitars, didn't have amps. And they would come to me: "If you're not working tonight, let me use your amplifier," and so on. And I would say, "Okay, man, just make sure you play, because I intend to hear you and steal some licks." So I was always loaning some amps. And if I let anybody have it for any time, they'd never return it. On a couple of cuts on *Hoodoo Man Blues* with Junior Wells we used the Leslie speakers for the organ. A lot of kids would ask me what was that when I had that little funny sound, but the rest of the album was all Fender Bassman. But let me take you back for a minute.

The first time I got an endorsement was from Guild. Guild was makin' amps then, and they came to me and said, "You come to the factory, and we're gonna' make you what you want." And they told me to bring my Fender Bassman amp in. And they kept it for two years, and then called and the engineer said, "You come and get it, because I can't reproduce that." They used to put it on the monitor, and every time I'd strike the guitar to show what the amp's doing, it was like a speeding automobile, hiding the needle, while those other ones was scufflin' trying to get it up to 60, 80, or whatever points they wanted on the monitor. So they never did reproduce the Fender Bassman that Leo had made. Maybe there was something in the transformer they never did get. And then now people tells me it was the material, the wood, and so on, and I believe that.

What amp are you playing through now?

A Fender Bassman. They reissued the Fender Bassman, and I'm very proud of that; because to me, that's the guitar sound. Otis Rush had it. In the earlier days when I went to Chicago, Muddy Waters and Howlin' Wolf was giants in my book—there wasn't no Rolling Stones, no Beatles, there wasn't no super rock groups or nothin' like that. And we used to travel with the whole band in a car, because two guitar amps and a bass amp would fit in the trunk. And the little P.A. system with two speakers in it would fold up like a little suitcase, and all that went in the trunk along with your own personal microphone. And when you'd get there you set the two little speakers on each side of the stage and set your mike up. All the guitar amplifiers were so small, but when you played the blues you could hear it very well. 'Course we wasn't playing in as big of places as we are now.

And then came along the Fender Bassman, which was a little larger than the ones we had then. That stayed until the '60s, when the British got it and the amplifiers started getting larger and larger. And then you needed an extra man to carry your amp. [*Laughs.*] As small as I was, I couldn't carry the big amplifiers they was makin', so I had to have somebody really love my music just to follow me and help me carry—otherwise you stayed at home.

What are your stage settings?

On the Bassman everything's wide open but the bass—no bass at all. That amplifier don't have that much to open up no-ways, you know. It's simple, just like the old Strat guitar.

Do you still own your original Bassman?

I got my old Bassman saved. Actually, I would love to have it installed in the wall of my house, so if somebody do happen one day to decide to break in, they would say, "It's too much trouble to get that." Yeah, I've still got the same covering on it, but I don't play at home. When I sound good, I want somebody else to share it with me. I don't want it to sound good just to me. I want to bring my sound out there and look at the expression on your face and the other fans, and let them say "wow!" Then I go home and feel good.

See, I don't say, "I'm the best guitar player"—I don't do that. If somebody else says it, fine, but I don't never say that. Because they got too many great guitarists, just like they got good-looking men, good-looking women all over the world. Every time I go to different country, I'm saying, "I thought I saw the best looking woman in the world." And it comes better and better wherever you go—every time you go somewhere, man. So I'm just happy living and looking and learning and watching all this from the music on down to the human beings. If everybody felt like me, wouldn't nobody in the world have a problem, because they would just listen to good music—guitars,

pianos, drums, and everything. They'd just smile and say, "I want to come back tomorrow for more so I can smile again. I'm tired of being mad at the world."

Thanks to the staff of the Newport Music Hall in Columbus, Ohio, for their assistance in facilitating the Buddy Guy and Albert Collins interviews.

VITAL STATISTICS

Buddy's Strat gets more play than the Guild, but you can't prove it by the hole worn in the Guild's top from strumming. Buddy had it filled with clear epoxy to protect the wood.

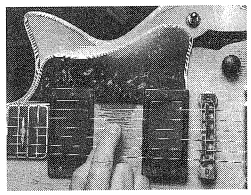


PHOTO: BRIAN BLAUSER

■ String gauge: On both guitars, Buddy uses Ernie Ball strings gauged .010, .011, .015, .028, .034, .044.

■ Neck width: Strat—1.685" at the nut, 2.055" at the 12th fret. Guild—1.703" at the nut, 2.070" at the 12th fret.

■ Fret size/height: Buddy agreed that his Fender needed fret work soon, and he'll send it back to the Custom Shop. Since Buddy plays so much, bends like crazy, and covers the entire fretboard, his Strat frets were worn uniformly flat, creating a sharp burr at the front edge of each one. You could almost cut yourself. Normally, a fret crowning would do the job, but his frets are also worn so low that the instrument needs a refret. The Guild's frets are still quite round and have a decent height.

Strat: .080" x .042" "vintage" wire measured .028" at the 7th fret and .032" at the upper frets—pretty low!

Guild: .108" x .045" Gibson-style fretwire averaged .030" to .035" all over.

■ Pickup height (measured from the top of the pickups to the bottom of a straightedge laid along the frets, with the guitar in the playing position). Note: Being Lace Sensors, the pickups can get closer to the strings without the magnetic pull common to traditional Strats (this magnetic pull can cause "Stratitis"—a difficulty in obtaining true intonation in the upper register).

Stratocaster:

Pickup	Bass Side	Treble Side
Neck	touching	touching
Middle	3/64"	3/64"
Bridge	3/64"	3/32"

Guild Nightingale:

I didn't measure these. They're EMG pickups, which can be very close without noise—and they were close!

■ Nut height/string clearance (with the guitar in the playing position, measured from the bottom of the string to top of the 1st fret): The clearance for both guitars was .010" for the high *E*, .022" for the low *E*.

■ Neck relief (measured at the 7th and 8th frets with guitar in the playing position and a long straightedge laying on the frets):

Strat: .011" Guild: .016"

■ String height at the 12th fret (bottom of outside *E* strings to the top of the 12th fret):

Strat: *E, A, D*—all 5/64"
G, B, E—all 1/16"
Guild: *E, A, D, G, B*— a heavy 3/32"
High *E*—5/64"

■ String width at the nut (measured with dial calipers from the outside *E* to *E*):

Strat: 1.437"

Guild: 1.421"

After reading Buddy Guy's interview you know why it's appropriate to run the King Of The Blues next. I truly believe that B.B. King is the man responsible for modern electric blues playing.

B.B. KING: talking about Lucille

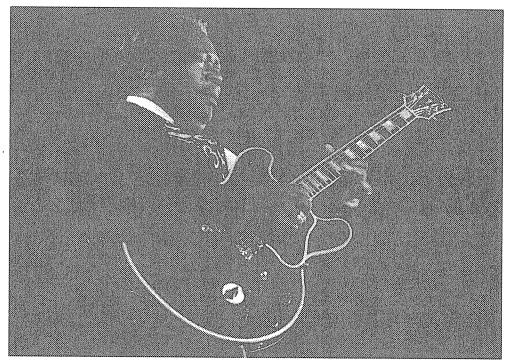
B.B. King would sound like himself on any guitar, because it's the man and his music—not so much the guitar—that's truly important. But on behalf of those of us who've spent hundreds of hours listening to this great bluesman and learning his style, I thought it would be beneficial to actually play Lucille and report on the type of action and response that lets B.B. do his thing. Perhaps these measurements and observations will help other players—especially blues newcomers—find what's right for them. At first B.B. seemed a little apprehensive about answering questions about the guitar rather than music. He began our conversation with a disclaimer:

"I'm like a test pilot for the airplane—he don't know much about it, he just flies it. An amp and a guitar, I don't know much about 'em. I just play—or at least try."

Have you ever been a do-it-yourselfer, adjusting and setting up your guitars?

Not too much, but some. I've been pretty satisfied with the way they're made by Gibson. I have done some little things, like setting the bridge intonation.

Did you help design Lucille?



PHOTOS: BRIAN BLAUSER, ATHENS, OH

Yes, a few little things. The ES-355 is practically the same thing, except that I wanted a thinline, semi-hollow, but also *solid*-body guitar with no f-holes, and they did that for me. So Lucille's like the big brother to the Les Paul. At one time I suggested that they narrow the neck a bit, and they did that for me. Also, the nut was a little different—I believe it was made of brass. With the current model they've returned to the usual white Gibson nut. And that's one of the things that's a little different.

How many Lucilles do you own?

Well, this is Lucille the 15th. I've given some of them away, and been ripped off for others—I mean, people have stolen them. Couple of times, they've come in the dressing room when I'd be talking to someone, and Lucille'd be in the next room. The last time, somebody went in that next room and got it. But luckily the sheriff was able to find it. A young fella had taken it home, and the funny thing was, when the sheriff came up to his house, he said, "Oh, did you come for the guitar?" [*Laughs.*] Yeah, that was the last time, but I've got about five or six of the Lucille model at this time.

Do you own any acoustics?

I've got two or three of them around home. One is an old National with the tin body and a resonator. I've got another one, but I can't think of the name now. The Gibson company is planning to give me one—at least one of the gentlemen there said they were going to.

One of the new flat-tops from Montana?

Mm-hmm, and that's what I want—one that's acoustic, but that you still can amplify. [*Author's note: Ren Ferguson, the man credited for the excellent guitars being built in Montana at this time, is making B.B. a very special J-2000*

with extensive abalone inlay. The flat-top will be a soft-shouldered, round cutaway with rosewood back and sides and a spruce top. The scale length will most likely be 24¾", like Lucille. This new "Lucille" will have a bridge transducer pickup and on-board electronics.]

Do you play acoustic at home?

Not often, but I do. I would rather play it at home [*laughs*] than let anybody hear me trying to play it out.

Do you play fingerstyle at all?

Oh no, I'm not that good—always a pick. In the early years I didn't have a pick. You know, I'm not as talented as a lot of people are; they can take the plectrum or use their fingers. It's all I can do to use the plectrum. So if I try to *divide* the time between the two, I don't do so well! I see Chet Atkins and guys like that just go to town with it, but I'm not able to do that.

Do you travel with more than one Lucille?

Yes, but until about a year ago I always just carried one Lucille. Then my manager suggested that I carry two in case something happened.

Is there a favorite Lucille, or one that's the most broken-in?

No, not really. It's like if you were drivin' a car—say, a Ford or Volkswagen, what have you—and you had two of them. They're both the same thing; it's just that one maybe feels a little different than the other. But actually the guitars' necks are pretty near the same.

You played heavy strings for years. In the old days they didn't have the light rock and roll strings.

The only strings I knew about in the beginning were called Black Diamonds, and gosh, it seemed to me that the first *E* string would have been the size of the *G* that I use today.

Could that have been what made your left hand so strong?

I won't say it's *what* made my hand strong, but I can say it probably did help. Then all of a sudden 20 years later somebody said, "Hey, man, have you tried the slinkies?" I said: "What? [*Laughs.*] The slinkies?" A .009 set, you know. So I tried 'em once, and it was like I'm playing with *toys*, so I took them off because my hands had gotten used to a specific gauge. For another thing, I'm not the best with chords, but I like light jazz. And I like rock—you know, I like some of *all* of it—but I can't seem to get the *sound* of the chords that I want with a real light-gauge string.

Do you ever get sore fingers from bending?

Yeah, my fingers get a little tender, but I don't have corns [callouses] on my fingers, like most people. And the action's pretty high on Lucille, a little higher now than I usually like it to be. I prefer it a little closer. The only time that I'll have a corn is if I don't play for awhile and then pick up the guitar—*then* I'll develop one. But usually my fingers stay very soft on the tips.

What fingers do you bend with?

A lot of people think it's only this one or that one, but I bend with all of 'em, and a lot with the third finger. The way I bend, I don't push it up or pull it—technically, you could say I'm just trilling. I bend with my little finger too. I guess, you know, I'm one of those guys that was never satisfied—never, never satisfied—so I was always tryin' to find something to add to what I was doing. So I didn't spend as much time practicing as I should have—still don't.

The Stratocaster is popular with all kinds of blues players. Have you ever messed around with one?

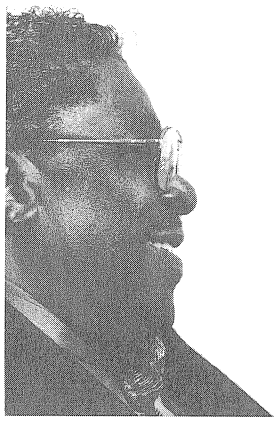
I had one of the first Fender guitars that came out.

The Strat?

If that's what it was [*chuckles*], I had one. You'll see a few of my early records with me holding it. But I believe it was a Telecaster.

When did you discover the semi-hollow-body guitar?

About '58 or so is when I got the first one, with the long neck—I believe it was called the ED-355 at the time. I got one of those, and I have liked them ever since. But my *first* Lucille was a little black Gibson acoustic guitar, and I used a DeArmond pickup on it to electrify. And my first amplifier, the very first one I ever had, was a little Gibson amplifier with something like about an 8" or 10" speaker in it—*one speaker.*



What amplifier would you recommend for small clubs?

I love the Fender Twin. When they first made the Twin, I used it all the time, because I never found another amp that satisfied me like it did. But when the company changed and went to a different type of amp during the '70s and '80s, then the sound somewhat changed too. So I started searching for something else, and that's when I found this Lab System, which is what I'm using now and which I like very much. Because with the Lab System I got a sound *similar* to the older Fender Twin, so I try to buy every Lab System I can find, because they stopped making them.

No more Fender Twins?

Oh, I still use the Twin too. Because with the Fender Twin, later on they returned to the old way of making them, and I again started to find the sound that I used to hear. You see, I didn't know much about the settings of those other amps, because I'm a three- or four-button guy, you know [*laughs*]. The volume, the bass, the treble, and reverb—and that's about me. So now, in my contracts, if they don't have a Lab System, which most often they don't, our contracts state that they must have a Fender Twin—and that's what I use all over the world. *[Albert Garcia of Fender explains, "The Fender Twins that B.B. didn't like were models where they added things like master volume, gain control, and a more powerful output and power supply that upped the power from 85 watts to 100 and finally to 135 watts. I'm sure he couldn't get his sound with it, because it's too powerful, for one thing. But now we have the '65 Twin Reissue—just like the original—with more simple controls, two channels, reverb, tremolo, and 85 watts."]*

Do you adjust the knobs on your guitar as you're playing?

Well, as you know, the guitar has tone controls as well as volume. The two front controls are volume for both pickups, and the rear controls are treble and bass. I use these controls all the time—up and down—according to the sound of my ear.

How about the settings of your amp?

My amp is turned up to the maximum, usually, as far as volume is concerned. If you were to think in terms of 1 to 10, the volume would be about 10, or maybe 8 or 9—not always *completely* wide open. It's according to how much balls it's got. If it's *really* hot, then about 8 for the volume. Now, I don't like a lot of bass since I can't hear it so well. Generally the bass would be between 5 and 6 most of the time. I have the treble up *all* the way practically, unless it's *very* hot—too hot for me—then it would be like around 7 or 8. But I prefer a lot of treble because I *can* hear treble, and with a good amp it usually cuts through pretty well. I like reverb, but not too much—just so it's not flat. So reverb would be about 2. That's the way I like the settings when it's a good amp, but I'm pretty rough on amps because I play pretty hard and I wear them out.

You wear them out?

Well, with the volume up strong—and I like a lot of feedback from time to time—that's pretty hard on an amp.

How do you get feedback?

I can find ways of getting feedback, which I can't explain really, but there are certain positions in which you can stand. You don't necessarily have to face the amp or have the guitar *toward* the amp. With this solidbody Lucille I can pretty well control feedback like I want. That feedback's pretty hard on an amp.

Do you have a special repairman or tech who works on your guitars, or do they go back to Gibson?

To Gibson, every time. After I've kept it for about a year or two, I usually will send Lucille back whenever she's startin' to wear a little bit. I get them to check her out, especially the frets.

Have you experimented with different fret wires?

No, this is the standard one that comes with the Lucille model [the wide oval, see measurements].

How often do you need a fret job?

About every four or five years, usually. I don't know, even though I slide up and down the fretboard a lot, I don't seem to wear them down like I've seen on some guys' guitars—I

guess the frets are pretty good on them. I've known some guys to file their frets down to where the fret is just above the neck. You know, where it's just out enough to fret it. But I don't like that.

You can't bend on those, right?

Yeah, I could. I can bend on any of 'em. Man you get me one and I'll bend 'em [laughs]—I don't care what kind it is.

Your adjustable Gibson TP6 tailpiece has the individual tuning screws removed. Why?

I don't like 'em, because they easily come out of tune for me. I took 'em off and threw 'em out! For some they may be good, but for me to have to reach back here [points to tailpiece] and tune, no! The next guitar, I plan to talk with Gibson and see if they can't just keep 'em off of mine. Another thing I like is the old style of tailpiece that holds on like a trapeze, so you just put the ball end of the string in the hole, and there it is. I'd like something like that. But if you ask about moving the bridge saddles, I do adjust them when the guitar seems to be out of tune with itself at times. I always check them at the 12th fret.

Do you use Lucille's Varitone switch much?

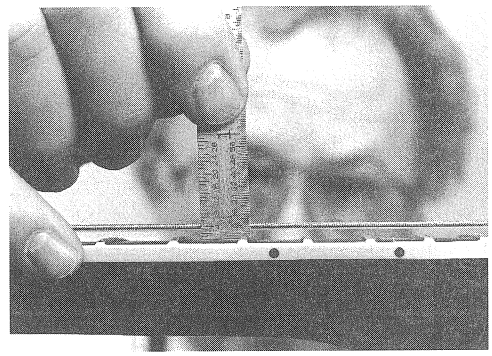
No, I hardly ever use it. Put it on full and just leave it there. To me, I can get a better sound mixing it myself.

Which pickup combination do you use most?

I leave the toggle switch in the middle most of the time. It's supposed to be stereo, right, so it's got two input jacks—one for mono and one for stereo. So generally the mono input jack is the one that I use most times with just a standard cord. It also has a stereo jack that uses a Y cord, so you can use two amps, right and left, and get the stereo sound with each amp working individually.

You mentioned that you like the long neck.

The guitar's got 22 frets on it. With the long neck joining the body way up, usually a guy with big hands like mine has no trouble going from here all the way down there to get it [*slides from the nut up to the high D*]. You got that *D* way up there on the 22nd fret, so you're all the way from here to there with ease.



PHOTOS: BRIAN BLAUSER, ATHENS, OH

B.B. likes a stiff action and a fairly heavy string.

What do you wipe your strings with when you're all done for the night?

Most times I'm kinda lazy, I don't wipe 'em down because when I come off the stage generally somebody else brings it off, and a lot of times I forget to do it when I get to my room. When I get to my room some nights, I'm so tired I put Lucille in one corner and I go in the other. But when I can *think* of it, the best thing to do is wipe the guitar down—then it won't corrode or rust. And my hands perspire so much, if I don't wipe 'em down they rust.

What brand of strings do you use?

I use Ernie Ball's light top/heavy bottom. I once used Gibson; I *liked* the Gibson strings, and I'm kind of a loyal guy. But then they started making the wound *G*'s, which I *don't* like. A wound *G* is nice if you're playing jazz, but I like to bend the strings somewhat. And the wound *G* doesn't get the sound, to me, when I'm bending. I can bend, but it's not the sound I'm looking for. My high *E* string is a .010, sometimes .011—I like 'em pretty heavy. A .013 generally, for the *B* string, and a .017 on the *G*. For the *D*, a .030—I prefer a .032, but the .030 usually comes in the set. The *A* string is a .045, and there's a .054 on the bottom *E*. That's what I use.

Do you change strings yourself?

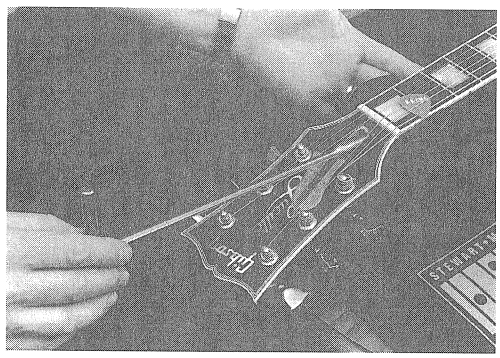
Always.

No guitar tech to do it for you?

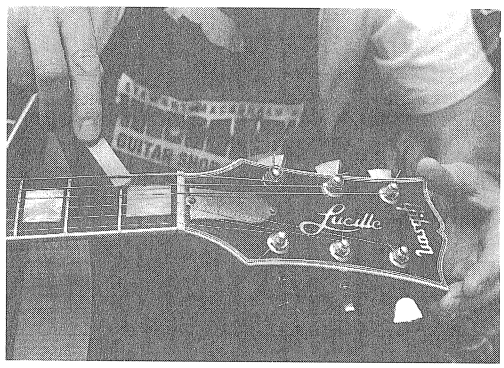
I can't afford it! No, it's me and Lucille. In fact, I broke a string onstage last night, but I'm pretty good with changing them. Usually I'll change before anybody really knows that I'm doing it.

Right while you're playing?

PHOTOS: BRIAN BLAUSER, ATHENS, OH



I didn't dare change the truss-rod setting without permission, but a quarter-turn would have significantly lowered the action.



Lucille has lots of string clearance at the first fret.

While I'm playing—never stop. I'll go into something that features somebody else, and if I'm playing a 12-bar thing, in 24 bars I've almost got it together—If it's a slow one.

Do you change strings for every show?

No, it's according to how much I'm playing. If I'm playing every night, about once a week. But if I break one, then I'll change the whole thing. It's like an old story about bears takin' corn out of the fields. If the bear had an armful of corn and he dropped one ear, he'd throw it all down and collect him another armful! [*Laughs.*] So that's the way I am about the guitar. I don't care if I changed last night, if I break one tonight, I'll take 'em all off and put a new set on.

You wind lots of string onto your tuners.

Again, I'm from the old school. We used to break strings so much, so you use it all! You wound it *all* up here [*points to pegheadl*], then if you break one, you still got more so you can pull it down and tie it on.

Do you run your strings through the post twice or have any special knots or ties?

No, I don't need to because I start to wind the strings from almost their beginning—for instance, like you take the average *E* string and pull it about an inch through—you can wind it about 12 times around there.

Maybe having that many windings is the key to staying in tune.

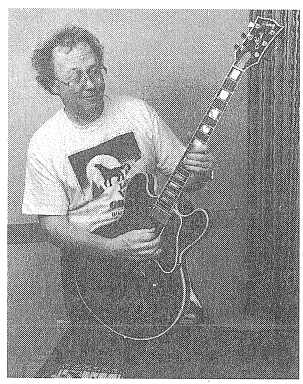
I don't know, but the tighter your string gets, the more it holds itself. My *B* string has about eight winds, about six or seven for the *G* string, and if I am in a hurry, I can put one on very fast. The only one that gives me trouble is the big *E*. Windin' it together up there gives me a little trouble. But at one time they had—and I liked it—keys with little cranks that you could fold out and wind the tuner very fast. I used to have 'em on the 355. I'm going to get them on Lucille *[Author's note: These M-6 Gold Crank tuners are still available.]*

Do you ever practice or play along to records?

I'm pigheaded. I've never learned that well that way. I read a little slowly, but if I really want to learn, then I buy the lead sheet on it and I sit down and play it. And nowadays I put it in the computer and let the computer play it. But that's the way I learn songs mostly. I've never been able to sit down and play a tune and learn it from that.

Like everybody has with your music?

Well, I guess. I don't have the knowledge of chord patterns like most people do. So, seeing is believing—hearin' is deceiving! [*Laughs.*]



Alone with Lucille: I just know that B.B. King sound's gotta be in there someplace!

LUCILLE'S VITAL STATISTICS

- Neck width: 1.698" at the nut, 2.055" at the 12th fret.
- Fret size: .098" wide x .045" (leveled and dressed, the frets range from .038" to .045", with an average height of .040").
- Polepiece height *(measured with the strings open rather than pressed down):* In the bridge position, 5/64" at the high *E*, 9/64" at the low *E*. The neck pickup's polepieces are 9/64" (almost 5/32") at the high *E*, 13/64" (a heavy 3/16") at the low *E*.
- Nut height/string clearance *(measured from the bottom of the string to top of the 1st fret):* .015 for the high *E*, .038" for the low. The open strings don't buzz.
- Neck relief *(measured at the 7th and 8th frets):* .030". This is a lot of relief. A more normal .015" could be accomplished by slightly tightening the truss rod a quarter-turn or less.
- String height at the 12th fret *(bottom of outside* E *strings to the top of the 12th fret):* All strings measured 7/64" in height across the board—a stiff, high action!
- String width at the nut *(measured with dial calipers from the outside* E *to* E*):* 1.425".

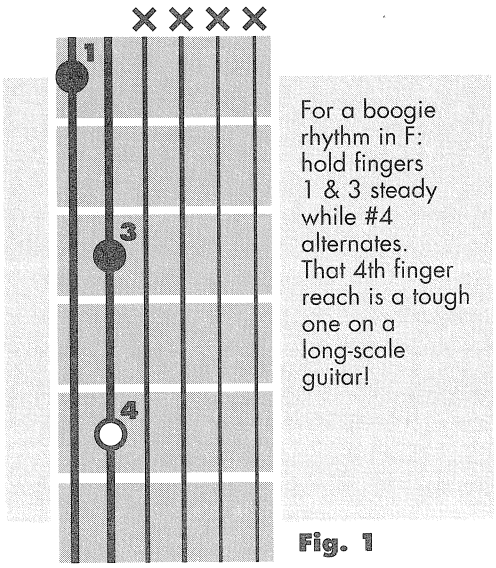
Get ready for the blues

A guitar that's out of tune or hard to play is *not* "close enough for the blues." But blues guitar setups are a little easier than most because the buzzing and dead notes caused by light strings, fretboard radius, and other factors are less apparent when the strings are raised—and most blues players seem to prefer higher action. Here are some points to consider when setting up a "blues" guitar—electric or acoustic—that will not only help you play better but may also influence your next guitar purchase.

SCALE LENGTH

Scale length is worth considering when choosing any guitar. Understanding why it's important will help your blues playing—especially in terms of bends and left-hand reach.

Most electric and acoustic steel-string guitars use either a "short" 24¾" scale (Gibson), the "long" 25½" scales (Fender, Gibson, and others), or something in between (PRS compromises with its 25" scale). Martin's short and long scales are 24.9" and 25.4", respectively. With its reduced string tension, the short scale is easier to bend on, responds quicker to the touch, and enables small hands to span greater distances. Short-scale guitars—electric and acoustic—make the best fingerpicking instruments.



For a boogie rhythm in F: hold fingers 1 & 3 steady while #4 alternates. That 4th finger reach is a tough one on a long-scale guitar!

Fig. 1

Because of its higher string tension, the long scale is louder and more powerful, has better individual note separation and definition, allows for heavier picking attack, and offers brighter, tighter sound. But a long scale is also harder to bend on, and long reaches are more difficult. According to Gibson's Tim Shaw, "When you play a chord on a short scale guitar, like most of the Gibsons used for blues, the strings 'blend' well and sound like a family singing together, like the Everly Brothers. On the other hand, chords played on the long scale sound more like hired professional singers—clean and perfect, but without the blend. As for hand size, when I play the basic two-string blues shuffle rhythm in the key of *F* [Fig. 1] on a long scale, my left-hand 4th finger barely reaches the 5th fret, but I can get it easily on a short scale."

FRETBOARD RADIUS

Your fretboard radius determines how close you can set your strings to the frets while still being able to bend the first and second strings without "bottoming out"— an Albert Kingism for a dead note that has "fretted out." Most vintage Fenders used a 7 ¼" radius while Gibsons used a 12" measurement. Simply put, the more-exaggerated Fender radius follows the hand's natural curve and facilitates barre chords. The same tight curve, however, may cause the aforementioned problems when the bent string runs into the slope of the fretboard, as shown in Fig. 2. Today, many Fenders have a flatter radius, but the company's vintage replicas retain the 7 ¼" dimension. Gibson's 12" radius has always facilitated blues bending with no bottoming out, even with low action. Martin's flatter 16" to 20" radius has never presented bending problems.

Fret size is very important if you bend a lot, and what blues player doesn't? Tall frets are much easier to bend on than low ones. Optimum blues fret height for unworn frets ranges between .035" and .055". Frets lower than .030" begin to give poor bending results, because they no longer hold the string far enough from the fretboard to prevent your finger from slipping off when it grabs and pushes. Fretwire for blues—and most modern guitar playing—falls into two size ranges: "thin,"

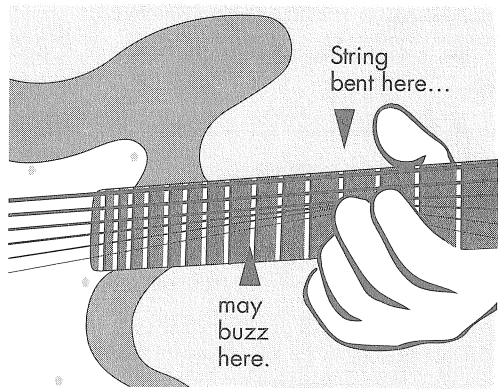


Fig. 2

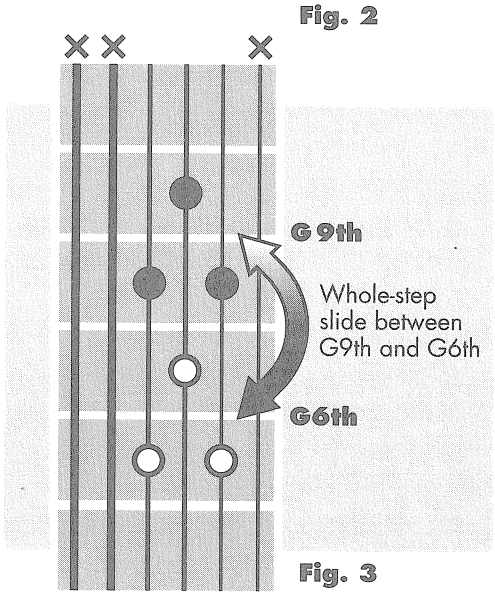


Fig. 3

.078" to .090" wide and .040" to .047" tall (Fender, Martin, Gretsch, and some older Gibsons); and "wide," .100" to .108" wide and .040" to .047" tall (Gibson and most others). While .055" to .060" extra-tall wire is available in either width and is great for bending, you may consider it too tall for blues chord slides, like the famous "6th to 9th" that we all use from time to time [Fig. 3].

NUT SLOTS

The depth and quality of a guitar's nut slots always affect its sound and playability. (For a guide to making a nut, see the Nut Work Chapter.) Normally, string slots are cut no deeper than one-half of a string's diameter, so that the strings don't become pinched or "muted." A blues setup, though, may require somewhat deeper slots on the treble strings (*G*, *B*, and *E*), since a first-string bend can cause the *B* string to pop out, especially when bending 2nd-fret *F#* up to *G* or *G#*. In this case,

Guitar	1st Fret	12th Fret	Relief
	high E/low E	high E/low E	
ES-345	.010/.024"	1/32–3/64"	None
Strat	.014/.034"	1/16–3/32"	.009"
J-45	.013/.022"	3/32–7/64"	None

Fig. 4

the short section of string between the fretted note and the nut is extremely taut, and you'll pop the string if you tend to slip your finger under the open *B*.

STRING GAUGE

String gauge can affect your style a lot, so experiment with all the gauges—from ultra-light to fairly heavy. But remember that each time you significantly change string gauge, you also change your setup. This will result in either spending some dollars at the local repair shop or learning to do the job yourself. As a general rule, the heavier the strings, the better the resistance to pick attack, so you can play things such as bass-string boogie/shuffle rhythms harder and with more drive.

Gradually grow accustomed to a heavier string gauge. For instance, don't bend a .012" first string without first toughening up. Otherwise, you risk getting "split nails," where the flesh of your finger pulls away from the nail. Splits are common and take about a week to go away. I've made it through many a night's playing by super-gluing the split, but I don't know if this is medically sound. Stevie Ray constantly glued his split nails.

The late Albert King may have been the most-copied blues player in the world, so he had a good thing going. He tuned way below concert pitch, *CFCFAD*, low to high—which for years allowed him to use Black Diamond silver-wound heavy-gauge acoustic strings and still be able to bend. In later years Albert used this set: .009, .012, .024 (wound), .028, .038, and .050. If you're studying Albert's style, try his strings—he didn't seem to prefer a particular brand—and tuning, and you'll be surprised. Stevie Ray Vaughan also tuned low, but only a half-step. His strings measured a hefty .013, .015, .019, .028, .038, and .058; even tuned down a half-step, you need extremely strong hands to do what he did. On an electric guitar, anything less than a .010 through .046 set is a little light for me, but I admit to occasionally using a .009 high-*E*. For years I preferred Gibson E-340 L Sonomatics (.011 through .056)

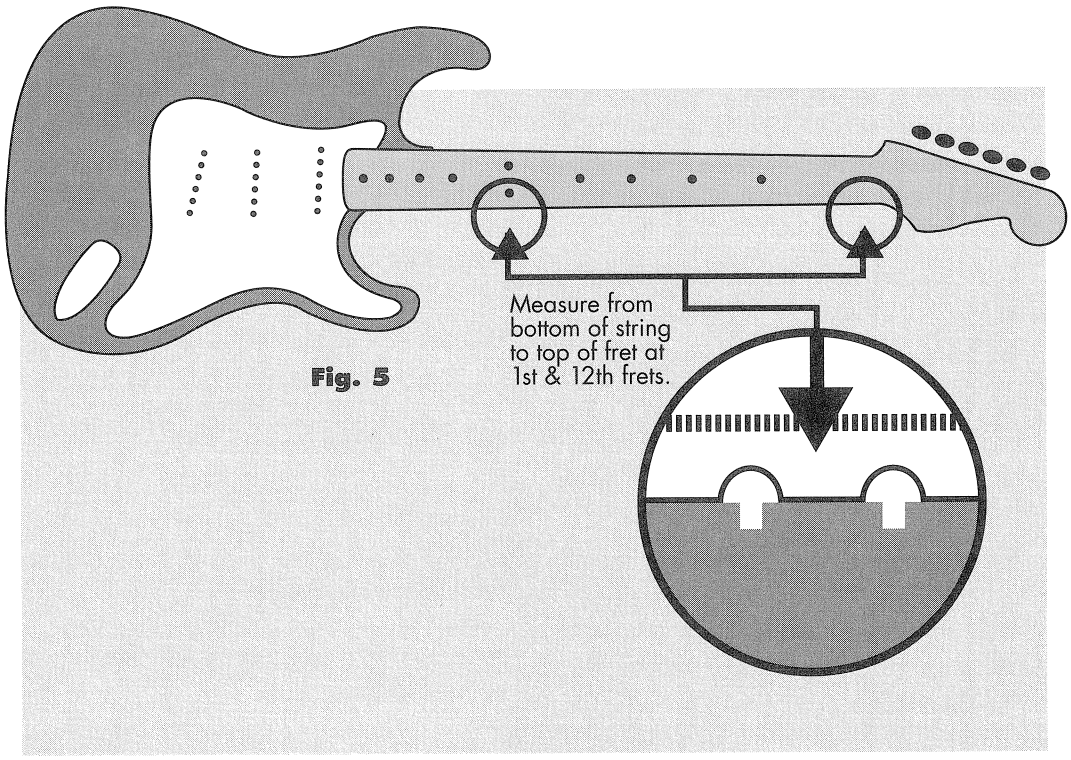


Fig. 5

because Otis Rush used them in the early '70s. E-340 L's came with a .019 wound third that sounded great; you could bend it, but it broke all the time. Try substituting an unwound .020 for the *G*, and you'll have a good, fairly heavy set.

For the average acoustic player, light-gauge strings are best for blues, unless the guitar is very old and can't support them. Extra- and ultra-light strings won't strengthen your hands or draw out that "different" style of music inside you. Medium-gauge strings may be too heavy for the tops of many acoustics, so have your local repair shop check out your instrument before you take the plunge. Strong hands are a must for playing blues on medium-gauge strings.

ACTION

Most guitars have adjustable bridges and necks, so setting action is relatively easy. As a precautionary measure, have a pro initially adjust your neck, and be sure to find out if the truss rod is working well. Necks are adjusted either perfectly straight or with "relief," a slight bow toward the strings' pull. Relief makes room for a vibrating string's elliptical pattern and helps avoid buzzing. You straighten a neck by tightening the truss rod, and relieve it by loosening the rod. There are hundreds of variations possible between straight and relieved necks, high or low string settings, and different string gauges, which is why you should learn to adjust your own neck and bridge. You may never know what setup is best until you've tried them all, so here are some helpful tips:

- Most of us like a neck that's adjusted as straight as we can get away with.
- You'll need a few simple tools, selected "Repairs" columns, one or two copies of this book, and at least a whole day to experiment.
- The heavier the strings and higher the action, the straighter you can adjust the neck.
- Light strings close to the fretboard need more relief.
- Short scales tend to buzz more easily if the strings are too low, so they need relief more than long scales.
- Fret buzzes not heard through your amp are okay.
- Straight necks and low action may work if you play with a light touch and a loud amp setting. Don't expect to bend notes very far with this setup.
- Gibson action can be adjusted more easily than Fender action because the entire bridge raises and lowers on two thumbwheels, whereas most Fender bridges—Strats in particular—have an adjustable bridge saddle for each string.
- Most electrics and acoustics should have relief that measures anywhere from .005" to .030" in the 7th- to 9th-fret area.
- Raising an acoustic's action at the bridge may require reshaping the saddle, which should probably be done by a pro. Sometimes you can simply shim or unshim the saddle's height.

To set your own action, start with the neck straight and lower the strings at the bridge until they buzz badly. Next slowly raise the bridge or individual saddles until the buzzing barely stops, and see how the action feels—you'll probably have a medium-low action that buzzes with relatively firm pick attack. Now give the neck a little relief and recheck the action. The buzzes should stop. The action will be higher, and you may end up liking this setup. If the buzzing doesn't stop, add relief until either it does go away, or the up-bow is so ridiculous that it feels uncomfortable. If you have to start over by re-straightening the neck and re-lowering the strings, try raising the bridge until the buzzing stops. You might like this medium-high strings/straight neck setup.

THREE TYPICAL BLUES SETUPS

The measurements in Fig. 4 were taken from a long-scale '56 Fender Strat, a short-scale '59 Gibson ES-345, and a 1944 short-scale Gibson J-45 acoustic. In each case, the guitars were lying on their sides in the true playing position when I measured them. Using a 6" steel "scale" and a set of feeler gauges, I recorded the distance between the bottom of the first and sixth strings (high and low *E*) and the top of the 1st and 12th frets (Fig. 5).

On the action/playability scale, I rate Fig. 4's setups like so:

1 The Strat is average to medium-high ("normal" Strat action), plays well, and the strings bend easily.

2 The ES-345 has a very low setup. Since it was a brand-new fret job, I was able to get the neck perfectly straight without buzz.

3 The light gauge strings on the J-45 provide enough tension so that the neck can be kept straight. It has low to medium action and plays great.

Pickup preference varies greatly, and I won't rehash pickups and electronics. For a rundown on how various pickups affect a guitar's sound, check out Alan di Perna's "Hot-Rod Your Axe" feature in the Feb. '91 issue of *Guitar Player*. Electric blues is played with humbucking or single-coil pickups and combinations thereof. B.B., Freddie and the late Albert King, early Eric Clapton, and the Allman Brothers all have a humbucking sound—a characteristic of Gibson ED-series semi-hollowbodies, SG's, and Les Pauls. For the single-coil sound, I think of Buddy Guy, Otis Rush, Magic Sam, and most of the current younger players like Robert Cray, Anson Funderburgh, Jimmie Vaughan, and the late Stevie Ray, all of whom use Fender Strats. A Telecaster also offers an excellent single-coil blues sound, but it isn't used as often. Some of the greatest blues guitars are the Gibson arch-top hollowbodies used by T-Bone Walker, Chuck Berry, and many '50s rockers, including the ES-295, the ES-300, the ES-350, and the ES-5 Switchmaster. Many of these early guitars were powered by "soap-bar" single-coil pickups and have a sound all their own.

As a rule, Gibson guitars—even with single-coil pickups—have more sustain, a fatter, thicker overall sound, and more output than Fenders. Strats are more percussive-sounding than Gibsons, but they have less sustain, unless you get them into the distortion mode.

Acoustic guitars draw a different style of blues performance from you, which is why they're so refreshing to play. To me, ideal guitars for playing acoustic blues have a shorter scale length, which leaves out most of the larger dreadnought-style instruments. Of course, you can play blues on a large guitar—think of Brownie McGhee—you just have to work harder. The short scale's lower string tension offers three advantages over the long-scale flat-tops:

1 It's more responsive to fingerstyle playing.

2 It's easier to bend on—even with light-gauge bronze strings, which are quite heavy compared with most electric sets.

3 It facilitates left-hand reach—an advantage if you're trying to play some of the nearly impossible things Robert Johnson did.

My favorite acoustic blues guitars are the early Gibson J-45, J-35, and the smaller L-0 or L-00 series, and all Martin 0-series models in either the 18 or 28 style (Big Bill Broonzy played an 000-28). To my knowledge, the only major company making short-scale guitars is Gibson, which is producing an excellent reissue of the J-45 and an improved X-braced L-1—sure to be a collector's item, since it is the model Robert Johnson played. A builder who makes custom short-scale flat-tops is Bill Collings (Collings Guitars, 1106-A S. 8th St., Austin, TX 78704). His guitars are expensive, but none are finer, and they sound as good as vintage instruments costing $10,000 and up!

Vintage blues guitar expert Dave Hussong of Fretware Guitars says: "Some customers put the cart before the horse when they shop for a blues guitar; if B.B. used an ES-345 with an Ampeg Gemini II amp, they've gotta have the same equipment. But the great players can produce their sound on just about any guitar. Hound Dog Taylor did fine with an Airline. The style overrides the instrument. The best blues setup can only be had after your style has developed. If you're just getting into blues, don't rush out and buy a guitar until you've played for a year or so. Use what you have, unless you're worried about all the great vintage guitars getting bought up.

"Fretwire size has never made much difference to me, but rosewood boards and big frets generally produce a big tone, and maple necks with smaller frets give you the brighter tone. I don't like low action and still subscribe to the Texas school of players like T-Bone Walker,

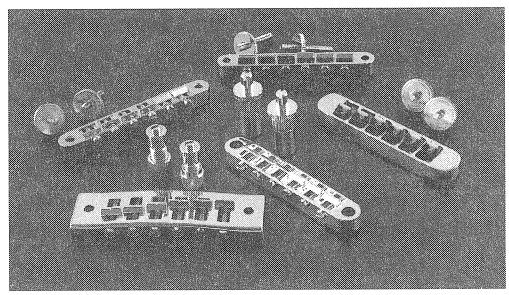
Lowell Fulson, and others, which means that I use as heavy a string as I can handle. Right now I'm playing an .010 through .050 set.

"My two favorite blues guitars are a 1960 Shoreline Gold Fender Strat, which is on loan to me from Anson Funderburgh, and a 1982 Gibson ES-355 with the wide 1 11/16" neck. If you've been playing a Strat and then pick up the Gibson, it's like a ball player laying down his heavy practice bat as he steps up to the plate. You've got to fight the Strat more, while the Gibson is easier to play. But a Strat has a certain tone all its own. When you're out there playing, you're more committed on a Strat, which means your mistakes will be more obvious."

Fitting and replacing Gibson Tune-O-Matic saddles

A Gibson electric guitar's adjustable bridge occasionally needs cleaning, lubricating, de-rusting, dusting, fine tuning, and calibrating too. Use the cleaning techniques used on the Strat bridge in the previous section which apply to all electric guitar and bass bridges, and not just those made by Fender. Gibson's Tune-O-Matic bridges, however, need certain adjustments that the simple, flat-plate, Fender-style bridges don't. Tune-O-Matics are die-cast, with individual channels for adjustable string inserts. Periodically these bridges need to be dismantled, have their parts cleaned and refitted, or be replaced altogether. Here are some set-up and maintenance tips for owners of these Tune-O-Matic–style bridges.

THE VARIOUS TUNE-O-MATIC MODELS



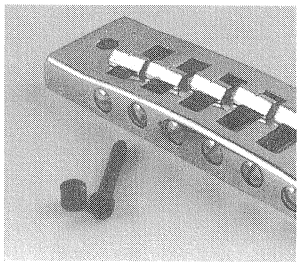
Gibson has offered five different adjustable Tune-O-Matic bridges since the original ABR-1 was first used in 1957: the Three Point, the Top Adjust, the Wide Schaller, the Nashville, and the original ABR-1. Parts or complete bridge assemblies for the Schaller, Nashville, and ABR-1 are currently available; the Three Point and Top Adjust have been dropped, and their parts are no longer available. We'll deal with the bridges and parts that Gibson still offers.

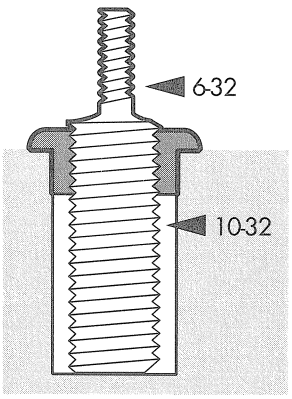
Metal bridge parts can be cleaned with lighter fluid and treated lightly with sewing machine oil or Teflon lube.

■ A wider bridge provides more travel for the saddles. All three of the current bridges are similar in that they raise up or down and their inserts adjust back and forth for intonation. Since the wider bridge offers more travel for the saddles, there is more latitude for setting

accurate intonation when it comes to action height and string gauge. The Schaller is the widest, the Nashville in between, and the ABR-1 is the narrowest. With the original ABR-1, if the bridge isn't mounted in just the right spot (as is sometimes the case), getting the correct intonation is difficult. The other two bridges offer more string-length adjustment, so one way of correcting poor intonation is to mount a wider bridge in the same mounting holes used by the ABR-1. Another method is to first plug the ABR-1 stud holes, and then relocate and redrill the stud holes without switching bridge styles. Note: If you own a valuable vintage piece, think twice about doing this, and then go consult a professional.

■ One of the most solid of all the bridge mounts, the Schaller was introduced in '72 as a stock item on SGs, and then on Marauders, L5- and L6-S models, and other Gibsons. Its height-adjusting studs screw into heavy steel anchor bushings that are pressed tightly into the top. Older Schaller bridges can suffer from flaked plating and metal deterioration caused by sweat, and it's often necessary to replace the pitted bridge saddles and sometimes the entire assembly. The saddles may appear to be permanently locked in by a machine screw with a slot-head on each end, but they're not! One end of the machine screw threads into the other and is super-glued in place. Since you won't know which end is glued (it's usually the backside, away from the headstock), heat *both* bolt ends with a hot soldering iron (40 to 45 watts) to break the glue joint, and then unscrew the bolts from each other. Replacement saddles for the Schaller come in a set (#10176) and are numbered from 1 through 6. Be sure to install them in the right order!





10-32 threaded rod turned on lathe and given a 6-32 thread

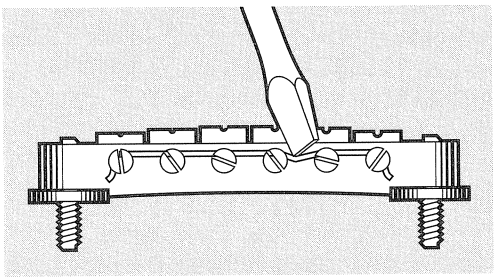
■ The Nashville bridge is the "new, improved" version of the ABR-1. It looks very similar, but it has more travel since it's wider by 7⁄64", and it doesn't need a retainer spring to hold the saddles into the bridge body. (Neither the Nashville nor the Schaller require the thin wire retainer spring that the ABR-1 uses to keep the saddles from popping out; this is a plus to some players.) It mounts on threaded flanged inserts that are pressed into the body, although the inserts aren't the same as the heavier Schaller anchor bushings. If your guitar is equipped with the Nashville bridge, you may find that the body anchors pull out too easily; in some cases, they want to fall out. I prefer a tighter fit than this for good tone transmission. You can carefully line the hole in the body with epoxy, white glue, or super glue, let it dry, and then refit the bushing. This tiny increase in the walls of the hole usually makes for a tight fit. If it becomes too tight, you need to scrape the walls slightly to remove excess glue. Working with glue—especially super glue—around a finish can have disastrous results, so be careful. A safer way to firm the bushing is to omit the glue, and instead wrap the bushing with Teflon plumbing tape before pressing it in; or increase the bushing's outside diameter by coating it with glue (instead of lining the hole with glue).

Here's a neat trick for Nashville bridge anchors, taught to me by my friend Bob Pettingill of Carrollton, Georgia. Besides being a top-notch guitarist, Bob is a machinist by trade. He put his machining mind to the task of making the loose anchors on his Gibson Les Paul more solid, and here's what he came up with. He took a short (2" to 3") length of 10-32 threaded rod and turned a small section (about ½") of it down in size to .136" in diameter. He then threaded the turned-down part with a 6-32 tap. Next, by carefully measuring to the bottom of the anchor bushing hole in the Les Paul body and carefully trimming the length of his new part, he got the new bridge stud to bottom out on the wood at the hole's bottom (pictured at lower left), while leaving the new 6-32 threads above the body surface. Now he can raise or lower his bridge with standard ABR-1 thumbwheels used on the turned-down 6-32 thread section. Going through the anchor bushings and down to the wood, the custom studs are very rigid, appreciably improving the tone and sustain!

■ Unlike most imported copies, all three Gibson bridges are available with saddles that aren't prenotched. Be sure to specify that you want them this way. The replacement saddles have no notches, either. This allows the player or repairman to individually notch the strings into the saddles for custom string placement. The imported ones—even Gotoh, which I

like—come prenotched, and this is less desirable in many situations.

■ To say that the Nashville bridge is new and improved implies that something is wrong with the ABR-1, which isn't really the case. In fact, when properly located for intonation, I prefer the ABR-1, because it's the bridge I grew up with, it looks "right," and it has a certain tone. While the major drawback (to some) of this original Tune-O-Matic is its narrower string travel, it does have a few quirks of its own. The ABR-1 retainer spring, which holds the saddle inserts into the bridge body, has a tendency to spring upward and buzz against the strings. You can correct this by pressing or "kinking" the spring downward in between the slotted screw heads with a small screwdriver tip.



Not all retainer springs cause problems, though, especially on vintage instruments. With the Nashville and Gotoh bridges, you will find some variation of a snap ring or spring clip holding the insert into the bridge body; these must be carefully pried loose before you can remove the bridge screw and saddle insert. This is actually a tricky job, and you need to apply downward pressure to both lips of the snap ring at once, using two pieces of blunt steel as "push-bars". I have often planned on making a scissor-like tool similar to "snap-ring" pliers that would gently squeeze the clip open—but I haven't made it yet! Just be careful, since every slip can chip plating from the bridge parts.

■ Some owners of vintage Gibsons equipped with the ABR-1 may notice a buzzing problem or strange-feeling action caused by a warped bridge. This isn't common, but I've seen it often over the years. Perhaps the problem is caused not only by metal fatigue, but also by a player resting his hand heavily on the bridge while picking. Sometimes you can flatten out the warp, and sometimes you can't. Don't try it yourself. Take it to a qualified repairman or to a machine shop where the craftsmen are familiar with the metals and stresses involved. With the bridge supported on each end, an arbor press or C-clamp can be used to gently push in the middle until the warp straightens out. You actually have to press the casting past the original point of flatness to get it to spring back true—a tricky task. Too much pressure or too fast a change can cause the casting to crack, so go easy.

■ On older instruments, especially those that were played hard, the studs that support the ABR-1 bridge have a tendency to loosen, bend, and/or lean forward. The most obvious solution to this is to redrill (enlarge) the stud holes and replace them with modern steel inserts and a modern bridge—either Schaller or Nashville. But this could harm a guitar's resale value, and we try not to alter guitar history, right? Here are *some* of the alternate ways to fix worn stud holes, made possible because the ABR-1 mounting hole spacing is so close to that of the Schaller, Nashville, and Gotoh replacement bridges. As a general rule, they're interchangeable. The hole-to-hole stud centers for the various bridge bodies are: ABR-1, 2.891"; Nashville, 2.926"; Wide Schaller, 2.891"; Gotoh ABR-1 copy, 2.891"; and Gotoh Nashville copy, 2.904". There are exceptions to every rule, so always double-check all measurements before making any changes. You might have a *little* trouble getting the Nashville (2.926") and the ABR-1 (2.891") to interchange; it depends on the individual situation. Also, if you're doing any drilling, tapping, or parts-switching, practice the operations on a scrap block of wood to be sure everything fits!

On some current Gibson bridges, parts are metric. For example, new Nashville bridge studs are 5mm x .8mm, not 10-32. Check thread sizes before you start drilling or tapping!

VARIOUS WAYS ABR-1 BRIDGE STUDS ARE REPLACED

1 If the wear is minor and the bridge is just a little wobbly, remove the studs and coat the walls of the holes with super glue, epoxy, or white glue. This not only increases the hole size, but hardens the thread cut into the wood by the stud. Next "chase" (that is, follow a thread lightly with a cutting tool) the threads in the wood with a 6-32 metal tap to re-cut accurate threads, and again coat the new threads with super glue to harden them. Chase the

threads one last time with the tap, and you should have tight-fitting studs.

2 Drill-out the worn hole to enlarge it, fill it with a hardwood dowel, then drill a fresh hole and install a new stud (use the 6-32 tap to cut threads into the wood before screwing in the stud). Warning: This drill-and-plug method is quite noticeable if you enlarge too much, unless you can do a very artful touch-up. Give some thought before trying this on a vintage piece!

3 Stay with a metal stud-into-wood design like the original, but switch to the Nashville mounting studs (but without the anchor bushing inserts). These have a larger thread (10-32) than the ABR-1 (6-32), allowing you to quickly and simply oversize the sloppy original hole with a #21 drill bit, and then rethread it oversize with a 10-32 tap; this method eliminates having to use a dowel plug. A Nashville bridge stud fits the new hole, but you'll need to find someone with a metal-working lathe to turn the top part of the Nashville stud small enough to fit the ABR-1 stud clearance holes. The thumbwheel part of the Nashville stud may need turning down a little, too.

4 Using the same oversize tap method, switch not only to the Nashville bridge *studs*, but use the Nashville *bridge*, as well. Again, don't use the Nashville anchor bushings. Mount the new studs directly into the top wood using the appropriate drill and tap listed above.

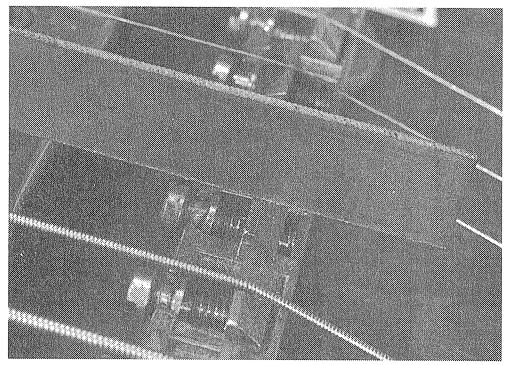
To get into these drilling, tapping, pressing, and fitting modifications, you're going to need a full drill index with fractional, number, and letter bits, as well as a good assortment of standard and metric taps and dies. You can buy bits and taps one at a time, as you need them. You need a pair of dial calipers, too, and the inexpensive ($25) plastic kind will do fine. Ask your local hardware store for an index that lists the decimal sizes for drills and taps, or check with any good machine shop. If you choose to install the Nashville flanged anchor yourself, note that a "J"-bit fits tight, while a 9/32" gives a nice press fit. For the wide Schaller anchor bushing, the 7/16" is a finger-press fit, while 27/64" is a pretty tight machine-press fit.

SLOTTING GIBSON BRIDGE SADDLES

Replacing worn bridge saddles is fairly simple, at least mechanically. But once the new saddle has been replaced, cutting a new string notch requires skill and special tools. Many of the techniques in the Nut Work chapter apply to shaping bridge inserts, so look ahead if you wish. Here's a brief rundown on the basics.

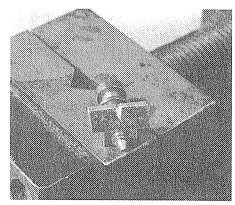
While Strat-style bridge saddles don't necessarily require a notch to keep the string in line, the Gibson style does. This is mostly due to the different string angle to the bridge saddle caused by having the separate tailpiece located behind the bridge. I use my nut-slotting files on a bridge although metal saddles are tougher on the tools than the bone, Micarta, or plastic used for nut making. Notch the saddles just deep enough to keep the string from moving to either side as you pick. This should *never* be more than one-half a string's diameter. The four steps for slotting a bridge saddle are:

1 Start a small notch with a nut-slotting file or a razor-saw.



2 Use different file sizes for the different strings (the nut-slotting files have round bottoms, which is nice).

3 "Ramp" the string slot, giving a slight taper toward the front of the saddle. Don't just cut any old "notch"—shape it nicely.



4 Deburr any wire edge, and polish the metal with 2000-grit sandpaper wrapped around a file which is several sizes smaller than the string slot.

Traditionally, the ABR-1 often comes with the treble (*E,B,G)* bridge saddles facing front and the bottom (*E,A,D*) saddles facing rearward for the best intonation. However, it's more difficult to shape the saddle peak that faces the rear because of its sharp edge, and I've found that when installing new saddles on the bass side I can often turn them around (sharp edge to the front) and notch them like the others. I still get good intonation, provided the bridge has been well-placed. Note: If you turn around a saddle that's already notched, you'll probably have to replace it entirely because the notch may be out of line (unless it's in the exact center). File the string notches with a slight taper toward the front edge, and deburr any wire edges left on the saddle. Once you set the intonation, the result should be a clean-sounding, accurately intonated string.

Bolt-on necks

What's the most indestructible electric guitar ever built? Many would bet on the Fender solidbody with its bolt-on neck.

When's the last time you saw a Strat or a Tele with a broken headstock or a cracked body? Aside from the basic setup, fretwork, and occasional electrical maintenance that all electrics require, these guitars can outlast their owners. However, the neck-body joint can be a troublesome spot for bolt-on owners, since its alignment controls the instrument's action and playability. Although attaching a neck to a body by means of four screws sounds simple, by understanding several key adjustment techniques you can get your guitar to play its best. Besides offering advice for vintage Fender owners, these pages on bolt-on necks should be required reading for kit guitar builders about to design and assemble their first instruments, since the biggest problem these new luthiers face is getting the neck set into the body so that the action feels right.

The most common adjustment made on bolt-on guitars is the realignment—or shifting—of the neck. This becomes necessary when the strings are falling off either edge of the fingerboard, even when you're playing the simplest of chords. When you're looking at the guitar from the front, the two outer E strings should line up equally to an imaginary center line, with neither being closer to the fingerboard's edge than the other. Because Fenders are designed with fairly wide bridge spacing and a fairly narrow fingerboard, the outer two strings are quite close to the fingerboard's edge to *begin* with. If the neck is even slightly out of alignment, the high- or low-*E* string will lean too close to either edge.

The techniques of filing and chisel-trimming the neck pocket to size can be used for fitting new parts, too. When I get a kit neck and body that fit too tight, I'm happy—I want a snug fit!

To correct this problem, slightly loosen the four mounting screws. Then hold the guitar in the playing position, edge down, on a table by gripping the body between your chest and one arm. With your free hand, give the neck a slight sideways pull in the direction that you wish to move the strings. Because the screws are only slightly loosened, enough grip should remain to hold the neck in its new position while you retighten the screws. If the neck still remains out of place after you shift it and retighten, you may have to use force to hold it in position while you tighten the screws (this can be tricky if you have only two hands). Some necks can be shifted without even loosening the screws—simply give the neck a quick jerk in the right direction.

A neat trick for keeping a neck in alignment is to slip a piece of metal screen-door mesh (or drywall sandpaper) between the neck and body. The mesh embeds itself into each surface's lacquer, creating a friction that makes it hard for the parts to shift. This slightly raises the neck's height in the body cavity, so you'll have to readjust the bridge and pickup height.

If the fit between the neck and body is so tight that there's no gap on the side you're shifting toward, you won't be able to move the neck without removing a small amount of wood (or excess finish) from the body cavity. If doing this makes you nervous, have a pro do it. But if you'd like to try it, go slowly and carefully. Avoid chipping the finish, removing too much wood, or removing wood in the wrong place. Lay a strip of masking tape on the body close along the neck, with just the amount of body/finish showing that you feel should be

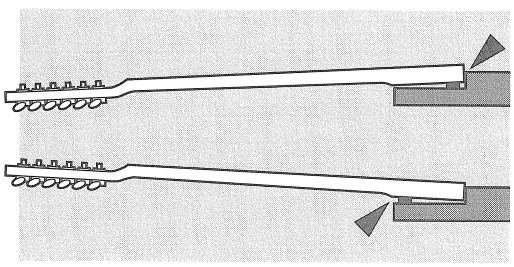
removed. (The arrows in the drawing at right show where wood may need to be removed to provide more room for the neck to move from side to side.)

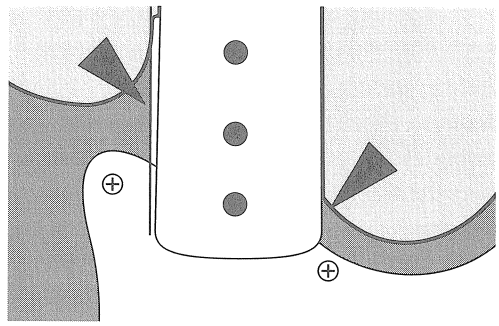
After removing the neck and pickguard, use a smooth file held at an angle to file the paint back to the tape line (middle drawing).

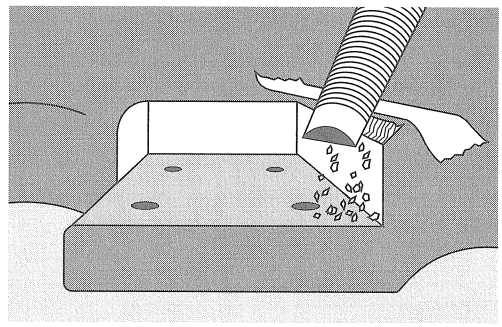
When you've filed to the tape, stop. Switching to a sharp wood chisel held at right angles to the body, pare away small bits of wood until you've removed the proper amount. Use the tape as your guideline as you chisel away the obstructing wood. Avoid touching the paint with the chisel, since paint chips easily. If you have a tight-fitting pickguard, you may have to file a small amount off that, too, before the neck will fit.

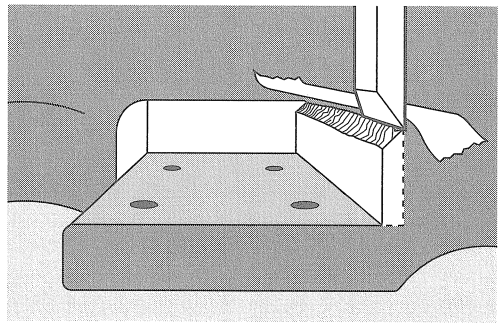
A bolt-on guitar's string height and action is controlled by adjusting the height of the bridge inserts. It's not uncommon to find a guitar with strings that are too high, even though the inserts are as low as they'll go. You may also find one that has strings that are too low, despite the bridge pieces being in their highest positions. In either case, the neck needs shimming. Begin by setting your bridge pieces at the center of their height travel (up or down) and at a radius that conforms comfortably to the fingerboard radius. This way, you'll still have room for fine-tuning the inserts' height after shimming the neck angle.

Shimming involves slipping a piece of thin cardboard, wood, or plastic between the neck and cavity. Very little thickness makes a drastic effect in the action. Time-proven shims have been fashioned from playing cards, matchbook covers, and flatpicks. I once even found the tooth of a comb used as a shim. If your strings are too high, making playing uncomfortable, put the shim at the end of the neck that's closest to the inside end of the body cavity (this is where shims are most likely to be needed). If





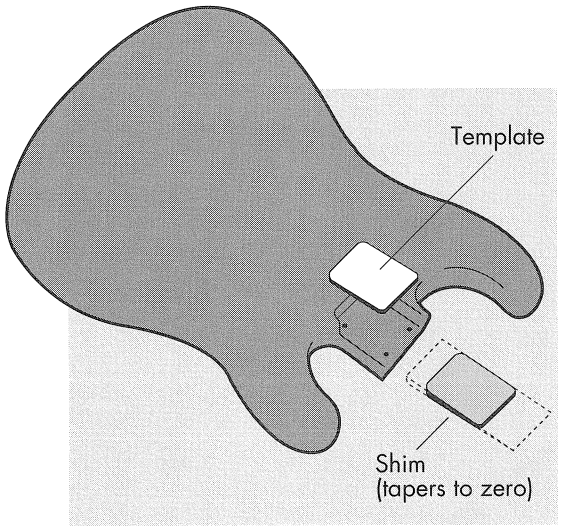




the strings are too low, place the shim towards the front of the cavity, just ahead of the two forward mounting screws. Proceed by trial and error—put in the shim, refasten the neck (holding the guitar as level as possible to prevent the shim from sliding out of place), and retune to pitch. It's best to start off using a matchbook cover; one thickness usually works, and two thicknesses are usually too much. Experiment, and remember that screen-door mesh not only keeps the neck in place, but makes a good shim, as well. You should have a comfortable action when done.

THREE-BOLTERS

Many Strats made during the '70s have a three-bolt neck mount with an adjustable tilt mechanism. These are a little more difficult to get snug, and I advise you to see your repairman for help. One solution—and I'm not necessarily recommending it—is to install a



fourth bolt under the three-bolt plate. This bolt can be countersunk into the wood and completely hidden. Ask your repairman about this and other methods.

Now we'll look at stripped neck holes, mounting a new neck by drilling your own mounting holes, and making a tapered, full-size wood shim.

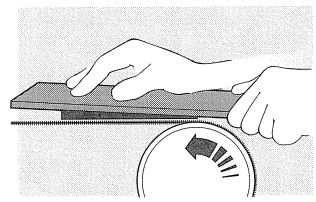
FULL SHIMS, KIT NECKS, AND STRIPPED SCREW HOLES

Let's take a look at how to install a full-size, gap-filling shim between the neck and body, at ideas for mounting a new kit neck on a body you already have, and at tips for fixing stripped mounting-screw holes in a vintage neck.

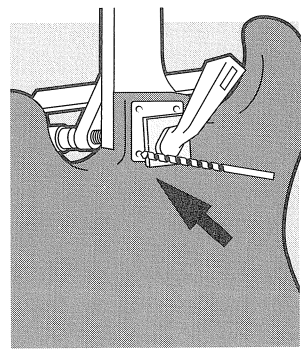
First, here's a reference for the drill sizes used in this section: For the four holes in the neck that the screws thread into, use a #30 bit. For the clearance hole where the screw passes through the guitar body, use a 3/16". A #13 bit is used to enlarge worn-out neck holes in preparation for plugging. Use whatever snugly matches the body clearance holes (usually a 3/16" bit) as a centering marker for layout of the four holes in the new neck.

The small neck shim described earlier leaves an air space in the joint. This gap may cause an upward warp, "kink," or "hump" in the neck. And many players feel that they suffer a loss of tone unless firm contact is maintained between the neck and body. For these two reasons, a full-size shim that fills the entire gap is often preferred. I make these full shims out of mahogany, which is soft enough to shape easily and hard enough to transmit tone. Before making the *full* shim, first shim the neck with a small sliver of wood as described earlier. This gives you the proper thickness of the new shim at its thickest part. Measure this test shim with a pair of calipers that read in thousandths of an inch, or use a feeler gauge. Next, trim and fit a piece of cardboard to fit the cavity perfectly (see drawing, left). Hold it in place and mark out the four holes from the rear, using a 3/16" drill bit. Use this cardboard template to mark out the mahogany shim.

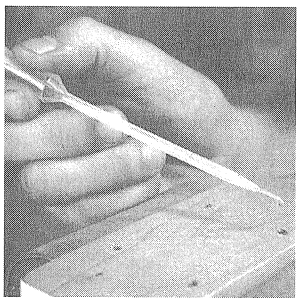
Start with a piece of wood that's 1/8" thick and slightly larger than the cardboard template. The grain should run lengthwise with the body. Trace around the template onto the wood, drill out the holes, and file, whittle, or sand to shape. Use a few strips of double-stick carpet tape to fasten the shim to a piece of hard, flat wood that's as wide as your shim and about 6" longer. This will be your backing support while sanding, with the extra length serving as a handle. Before sanding, lay out the taper of the shim with a sharp pencil, matching the thickest measurement that you made earlier at one end, and tapering the other to nothing. This line is your sanding guide. Hold the support block with the attached shim in one hand while using your free hand to press it against a belt sander equipped with a medium- or fine-grit belt. Although it may take several tries, you'll end up with a sliver of mahogany matching your thickest measurement at one end and feathered out to zero at the other end—very fragile!



Replacement or kit necks often arrive without the four mounting screw holes already drilled. I prefer ordering them this way, since it allows me to really line things up properly before drilling the holes myself. Set the neck into the cavity and clamp it while you install the two outside *E* strings for alignment. When the strings are in line with the fingerboard's edges, run the proper drill bit (3/16") through the hole. You'll feel when it touches the neck. Rotate the bit with your fingers to start the holes; then remove the neck and change drill bits to a #30. Finish drilling the holes, using the starter marks as a guide.



Most neck-mounting screws are standard-size, and the hole they thread into is smaller than the outside of the thread, which leaves enough wood for the screw to bite into. Use an electric hand drill or a drill press and be sure



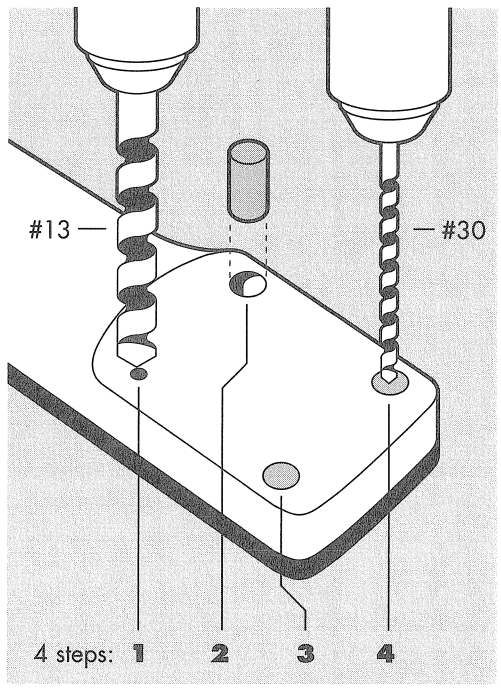
Here's an important bolt-on tip: When the neck's removed, seal its four neck-mounting screw holes with a drop of lacquer. This keeps moisture from absorbing into the tongue, which can cause a swelling or hump in the wood and frets. Try using a plastic pipette to add a drop of lacquer to the hole, and use an empty pipette to suction out the excess lacquer so the hole can dry. While you're at it, remove the truss-rod nut and seal up the hole bored into the end of the neck, too.

you drill perpendicular holes. If you measure the amount of screw showing through the cavity with the neck plate in place, you'll know how deep to drill without going through the fingerboard. Wrap a piece of masking tape around the drill-bit shank as a depth guide. After drilling the holes, pre-thread each hole with a mounting screw used as a tap. Rub the screw against some beeswax, paraffin, or paste wax to lubricate it before pre-threading each hole. Now mount the neck with the backplate and all four screws. It should line up with the strings.

If the four mounting holes in a used neck are stripped, try coating them with Hot Stuff Super T glue (the yellow bottle). This provides grip for the screw thread. Use a toothpick in each hole to spread the glue around, and let it dry for an hour or use Hot-Shot accelerator to speed up the cure. Repeat this operation several times, and then you can try rethreading the holes with well-waxed mounting screws. This usually solves the problem.

If the holes are too stripped, you need to drill each hole oversize, plug it with a hard-wood dowel, and redrill from scratch. Most worn holes may be plugged with a 3/16" (or less) wood dowel (above, right). To ensure a snug fit, you need to drill the oversized hole in the neck slightly smaller than the wood dowel; this is why you use the #13 bit, which is a few thousandths smaller than the dowel size. Whether you use a drill press or hand drill, remember that the neck is usually *hard* maple and may cause the drill bit to run off line, causing the hole to be drilled oversize or out of round. Always clamp an object that you are about to drill—especially maple.

After drilling the holes, cut four pieces of 3/16" maple or hardwood dowel (use a larger wood dowel and corresponding drill bit if the hole is really bad) approximately 5/8" deep, or whatever depth you have drilled into the back of the neck's heel. Coat the holes with Super T or carpenter's glue, and slowly press the dowels into the holes, one at a time, with a small hammer. When the glue has dried, trim the dowel ends if they aren't flush, and then clamp the neck back into the cavity and proceed as you would when installing a new neck with no holes. If you've been careful with your work,



the neck will tighten home snugly and serve for many years of playing.

BOLT-ON QUIRKS

I'm definitely a Strat lover, and I basically agree with vintage experts who advise players not to alter old instruments. But many Strat lovers are caught between the vintage purists and the modern high-tech mechanical marvels. We appreciate the locking nuts and tremolo systems, and we can dig the high-tech sounds offered by electronic advancement, yet we don't want to see that stuff on our Strats. But we also find a need for certain repairs, and in some cases alterations, on guitars that we play and never plan to get rid of. Thousands of players own good but not exactly "vintage" Strats that would be more playable if they allowed their guitars a fret job, for example.

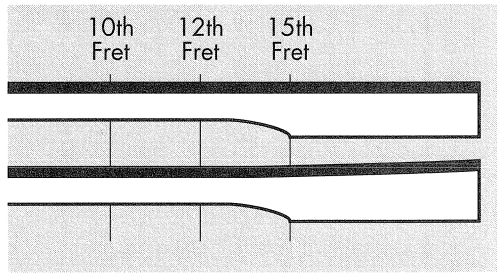
Forgetting twists, serious warps, broken truss rods, stripped truss rod threads (it's usually the easily replaceable nut that's stripped) and other subtle but hard-to-fix problems, we are left with two common Strat neck complaints: buzzing in the upper frets caused by a kinked neck or "rising tongue," and a fingerboard that's too radiused for bending strings without noting out. I, for one, don't think it's a sin to do fret work on a workingman's guitar, and I'll tell you why.

First off, I assume that you'll take your axe to

the best repairperson you can find—someone who's capable of adjusting necks, removing frets, planing out humps, and refretting with barely a trace of the work showing when done. Second, I know that some guitars just can't be played unless some "surgery" is performed. If your guitar is correctly adjusted and set up, yet you're still not satisfied, then the only thing standing between you and great playability (forgetting the electronics, of course) has to be the neck, and the fingerboard in particular. Here's how to go about solving these problems.

Buzzes up the neck are often caused by a swelling or hump that begins anywhere past the body joint. Many bolt-ons have a kink where the neck joins the body, due to the length and slimness of the neck, which is fastened abruptly to the body and placed under constant up-pressure from string pull. Sometimes these forces are more than the truss rod can correct. Also, the neck absorbs moisture through the four mounting-screw holes, as well as through the end-grain of the maple at the body edge. While lacquer is still my favorite finish for the neck and body, it doesn't impede the absorption of moisture as well as some other finishes. This moisture absorption can cause a slight swelling, noticed more often with rosewood fingerboards because of the extra swelling of the glue joint between the maple and rosewood. I've encountered fewer humps, swelling, or rising tongues on the old, pre-'59 maple necks.

A few pages back we mentioned that a shim placed under the neck to change the tilt can cause kinks, too. The thin strips of fill material that are commonly used as neck shims create an air space that allows the pressure of the four mounting screws to act as a clamp, forcing a rising tongue! Combined, these forces—string pressure, moisture absorption, and neck shims—can cause the last 6 or 8 frets to be higher than they should be, since the wood has risen. This doesn't always happen, but it's reasonable to expect it with a guitar made of wood. These problems can be corrected with either a fret dressing, which will remove the buzz from the frets, or by a partial refret, in which the last eight frets or so are removed, the rise is scraped and sanded from the fingerboard, and the original (or replacement) frets are reinstalled. If you're a novice and any fret work is involved, take the job to a professional. You may be advised to do a complete fret job as long as you're at it.

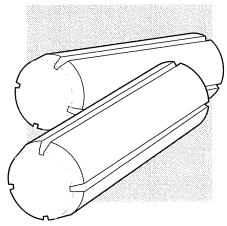


A hump, kink, or rising tongue can be detected by placing a 12" straightedge on the fingerboard alongside any given string. The guitar should be strung to pitch, resting in the playing position, with the straightedge running from around the 10th fret to the fingerboard's high end. When viewed from the side, the fingerboard should appear flat, with the frets level with each other. If you see any gap or relief on this portion of the fingerboard, the tongue is probably high. The drawing above shows two necks: the top neck shows the upper part of a flat fingerboard; the lower one shows the same part of a neck with a rise. Put a small straightedge on the two diagrams and see for yourself—then have your neck checked by a pro.

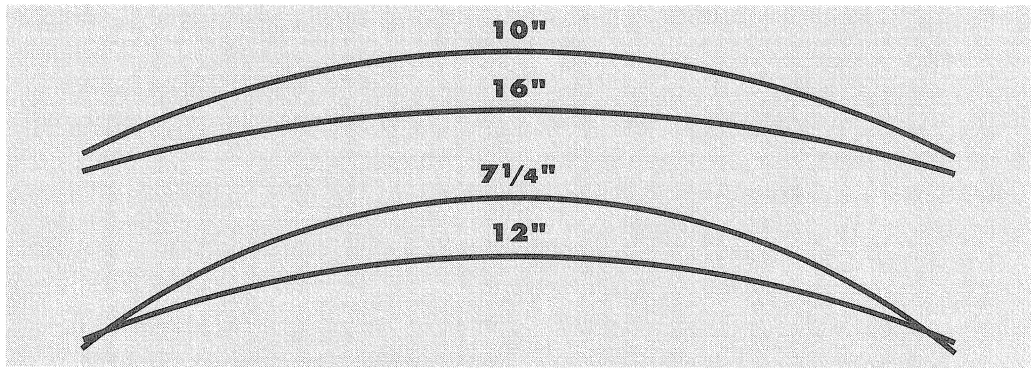
COMPOUND RADIUS FRETBOARDS

On vintage Strats, bluesy bends that fret out or buzz with a medium-to-low action setup are caused by the very curved 7¼" radius of the vintage fingerboard. Many players like the feel and comfort of the curve when playing barre chords, and country and jazz guitarists find less need for far-stretching blues bends. Most blues and rock players, however, run into bending problems—especially on the high-*E* and *B* strings, and usually in the upper register's 10th to 21st frets. Sometimes the easiest solution is to have metal dressed off the frets in the tongue area under the second and third strings—where the high-*E* and *B* strings end up when bent to their peak. But often this dressing solution is barely acceptable at best. The real answer lies in having a complete refret by an extremely good repairman experienced in *tapering* the fingerboard radius, gradually and subtly

If you have trouble seating a wood dowel into a tight hole (because of the hydraulic pressure created), try this furniture repair trick: With a thin razor saw cut several lengthwise slots in the dowel to let the air and excess glue escape—it will go in much easier!



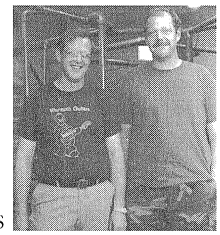
Compound or tapered radius fretboards aren't new. I recently worked on a lovely old C. Bruno guitar from the early 1900s that had a spruce top, Brazilian rosewood back and sides, pearl-inlaid soundhole, and an ebony bridge and fretboard —a compound radius fretboard which began at 5½" by the nut and tapered gradually to 12" at the end of the fretboard!



flattening it out as it goes up the neck and ending up with a 12" or 16" radius at the fingerboard's end. This is commonly known as a "compound" radius.

On a 7¼" radius fretboard, take a good look at a bend on the first string (at *least* a whole-step bend). The string is moving at an *uphill* angle towards or over the middle of the fingerboard radius; it *has* to buzz! If you really need proof, remove the top strings and set a straightedge on that same plane—it will rock on the spot that would cause a buzz. Since the strings rise on a long angle up and away from the fingerboard as they head toward the bridge, the fingerboard's radius need not be totally flat to be buzz-free, but 7¼" is pushing it. This is why Fender has begun using a 9" and 12" radius in recent years (only the vintage models still have a 7¼" radius). So, if you play on a vintage Strat (or a copy) your action mustn't be too low, if you want to play the blues.

Repairmen were pleasantly surprised when the Warmoth brothers came out with "Warmoth Radius," compound fingerboards on their replacement necks. After years of manufacturing necks with 10" radius fretboards, Warmoth switched entirely to the compound radius fretboards. The Warmoth Radius neck starts at 10" at the nut and tapers to 16" at the fingerboard's end. While these new necks can't help a vintage guitar's neck problems per se, they can save a lot of worry for players who question, "Should I do that to my Strat?" You can now buy a direct-fit replacement neck with a compound radius, usually for less than a high-class fret job, and try out its blues-bending capabilities while keeping the original neck stock. This can either be done as a test run before having a much-loved neck taper-radiused by a top fretman, or as a satisfying replacement that allows the original neck to be stored, unaltered and mint, until it's needed. I highly recommend the compound tapered radius for blues playing.



Ken and Paul Warmoth, along with their father, originated the non-factory replacement neck many years ago, and from the outset they perceived that players had some problems with a 7¼" radius. After discussing the situation with many repairmen, they decided to go with a fingerboard radius of 10", which is between Fender's and the Gibson 12". This 10" radius has since been the standard for almost all kit necks —so much so, in fact, that most locking nuts are made to match that radius. Therefore, if you plan to convert any guitar for a locking nut, check the fingerboard radius. You may find that you'll need to plane and refret the neck for optimum results. The arcs drawn above offer a comparison of different finger-board radii.

Caution: For more detailed information on the compound radius, see the Fretting chapter, and think carefully before flattening, tapering, or altering in any way the fingerboard on a vintage piece!

Tuner basics

There are many devices designed to help tune a guitar and keep it in tune. Electronic tuners and locking nuts have flooded the market, targeted especially at guitarists who use a tremolo. Many players never realize that one of the easiest ways to get in tune and stay there is to replace old, worn-out tuning machines that no longer hold their pitch. First we'll look at tuners in general, and then deal with their installation.

Tuners have three main parts: a plate or casting that holds the gear and shaft together, the drive shaft that's turned by the key or button, and the string-post shaft that's turned by the drive shaft. The drive shaft has a worm gear on one end, which drives the crown gear on the string post. The gears' housing is either the less-expensive, stamped-plate type made of steel, or a solid-metal enclosed unit known as a die-cast. The number of turns needed to cause the string post to go around one full turn indicates a tuner's gear ratio. Today most guitar tuners have a 14- or 15-to-1 ratio, while higher ratios of 20- or 24-to-1 are used on electric basses, which need the finer tuning capabilities due to their low-pitched, heavy strings (a higher ratio makes fine tuning easier).

Judge a tuner's quality by its "backlash"—the amount of free play felt when a peg is turned in an opposite direction without the string post moving. Also check to see if the post moves—thereby changing the pitch—without the tuning key being touched. Backlash is especially noticed by players who bend strings or use a tremolo, since when the constant pressure of the string at the post is altered, the string may not return to the original pitch. The locking nut is a good solution to backlash and post movement, but for vintage guitars, I feel that the tuners should be replaced before a locking nut is even considered. By eliminating backlash, you might solve most of your guitar's tuning problems. Better tuners have low amounts of end play (up-and-down movement of the string post) and shaft wobble (back-and-forth string

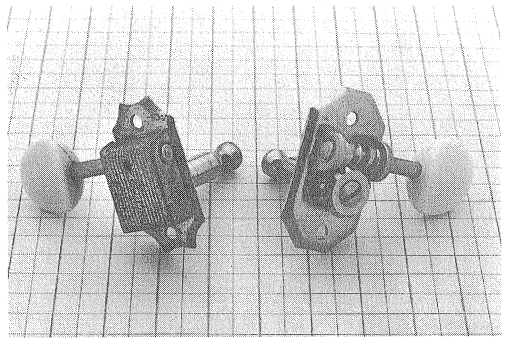
Don't blame the poor tuners if you haven't mastered tuning yet!

movement in the bushing, washer, or grommet on the headstock face).

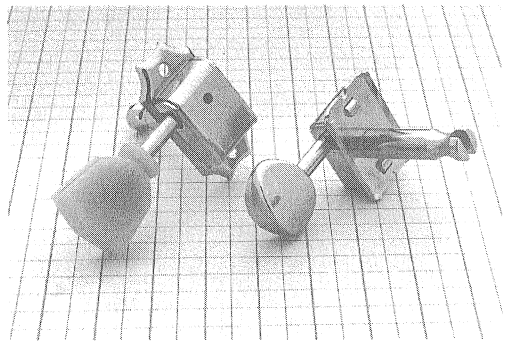
For years all tuners were constructed with either open gears or a semi-enclosed, stamped sheet-metal housing. Kluson, Waverly, and Grover were the big manufacturers, with Kluson leading the field. Kluson's Deluxe was not only the most widely used, but often the tuner most in need of replacement. They were notorious for backlash because their gears were made on a screw machine rather than a specialized, more accurate tool known as a gear hobber. Also, they made the worm gear from brass, when steel would have worn longer (all tuners today have a brass crown gear but use steel for the worm). Kluson tuners had a backlash the day they were born, but no one knew enough to complain. There wasn't anything better, so players put up with them until Grover came along with the Rotomatic, the first high-quality tuner. Its die-cast housing enclosed well-machined gears that were lifetime lubricated and completely sealed. In addition, a threaded bushing with extra length replaced the press-in grommet to better support the shaft (right). This tuner became the replacement choice of repairmen around the country—much to the owner's delight—as well as a factory-installed standard on many higher-end guitars. Years later the Rotomatic was copied, then improved upon, by Schaller and Gotoh. Between Grover, Schaller, Gotoh, and the lesser-known but equally high-quality Sperzels, you'll find a size, shape, and style to fit any guitar or bass.

While die-cast tuners are no doubt the most precisely made and offer the least amount of backlash, they are also more expensive. And because of their larger size, you'll have to do some drilling in order to use them as replacements for the old-style tuners with a smaller string-post diameter. They may not be a wise choice for a valuable vintage guitar or bass.

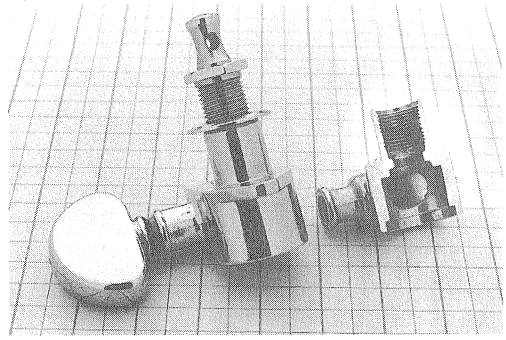
In the good old days, players had few choices when it came to solving tuning-key problems. You'd either install a set of die-cast Rotomatics or buy a new set of stamped factory replacements that were no better than the originals. Today's replacements for those old, low-priced Kluson Deluxe tuners are excellent. Modern



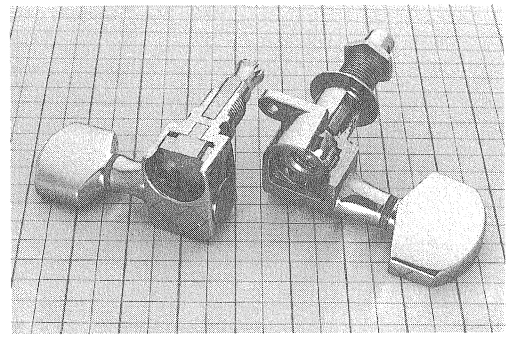
Early Klusons: the "Deluxe" (left), and the "Ideal."



Modern Kluson-style replacements: note Fender style slotted "SafetiPost" and trimmed plate.



Modern Rotomatic die-cast tuner. Note the threaded bushing for extra shaft support.



Sperzel tuner with the solid crown gear housing.

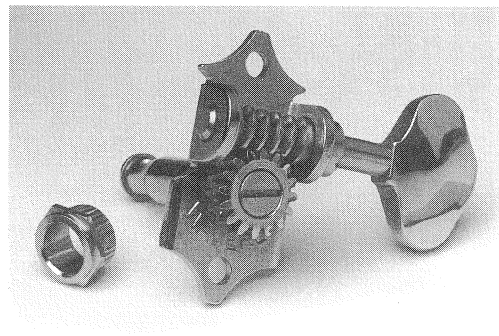
Deluxe styles offer a 14- or 15-to-1 gear ratio, compared to the old 12-to-1, which means closer tuning capabilities. Also, the gears are accurately machined—regardless of which brand you buy—with nylon washers added to

support end play on the worm gear, thereby eliminating much of the backlash. That means you're safe using them as an exact look-alike replacement, and you won't have to deface a vintage axe by drilling for the larger die-cast machines. Note: I seem to recall that the earliest Deluxe replacements had larger shafts than the vintage ¼" style—and a larger bushing ("grommet") too. So those tuners wouldn't just "drop right in" the existing bushings since the shaft was too large. In that case, the tuner bushing holes in the peghead face had to be enlarged to accommodate the new replacement bushing— which isn't preferred on a vintage axe! I believe that most of the manufacturers have taken care of this oversight, but be sure to shop around—I know that the Gotoh Deluxe replacements will fit vintage bushings. However, Gotoh's bushings still have a larger bushing O.D. (outside diameter) than the vintage ones by about .012" (.344" vs. .332"). These bushings will slide into some peghead holes but not others. It takes just a few minutes to file down the serrated "teeth" on the bushing sleeve until they fit, however.

Vintage Martin and Gibson guitars often used the Grover G-98. A perfect replacement for that peg is the Waverly W-16 (above). Although expensive, it's the best tuner I've ever used—including any enclosed or die-cast machines. This tuner will fit the plate "footprint" (imprint in the lacquer at the rear of the peg-head), and the mounting-hole spacing, of many guitars. If you're custom-ordering a new guitar, ask the manufacturer to use the W-16 tuners; you won't regret it. The W-16 will fit many Gibsons and Martins from the 1930s through the 1950s.

Waverly also offers vintage conversion bushings with an oversize outside diameter. These bushings fit the enlarged (usually ⅜") holes drilled in many vintage guitars for die-cast tuners, as mentioned above. So, it's now possible to convert back to vintage tuners while still retaining the right look. The Waverly retrofit bushings come in the Martin or Gibson "hex" style and the round Fender or Kluson Deluxe style.

If you want die-cast machines and you don't mind enlarging the holes, read the next section before attempting an installation. Or, since



Waverly W-16 tuners.

many guitars manufactured since the late '60s already have die-cast tuners, replacing them is easy; the hole is already the right size, and no drilling is needed. But even die-cast tuners wear out or eventually suffer from backlash. So if you're shopping for a new set, there are several points to consider. The first is size: Mini die-casts are available for headstocks that won't accept the standard ones (Fender, for example). You can also choose color—from black, gold, and chrome to red and blue. Several other options are available, such as string locks—miniature locks that are actually built into the posts to help control string slippage. Sperzel offers staggered-height string posts for Stratocaster-style headstocks, which keep a good angle at the nut without using string trees; this is a real enhancement when using a tremolo without a locking nut. Perhaps you need Fender's slotted SafetiPost and trimmed plate to fit a Fender. Also keep in mind that some sets are heavier than others, and try to find pegs that match the original shape and mounting screw holes. If properly matched, they'll drop right in, probably even matching the original press-marks in the lacquer.

Locking tuners are a great invention. They really help avoid tuning hassles.

Many players have no idea of the variety of tuners available today, and since they seldom browse through the catalogs at their local music store, they assume that what they see in the showcase is all that's available. Ask questions and shop around, so you can weigh the facts.

Tuner installation

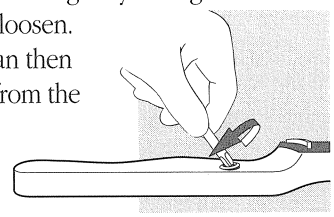
Before drilling any tuning key mounting holes, be sure to read about over-oiled tuners on page 88. People screw up this operation all the time. If you break off a screw—especially in maple—there's hell to pay getting the broken part out!

Those are the basics of tuning machine construction—from costly die-cast tuners to the less-expensive, stamped variety. Almost any of today's well-made, inexpensive tuners are a good replacement value. Here are a few more tuner facts, with some installation tips.

Not only are die-cast tuners accurate, but they also suffer the least from backlash. This doesn't mean that you can't tune well or won't be satisfied with stamped vintage replacements; you may well be. But die-cast tuners are the best, which is why you see them on most top-of-the-line instruments. (Would you put two-ply tires on a Cadillac?) Now, even die-cast tuners can develop backlash over the years: As the brass crown gear wears, the fit becomes looser. Another little-known fact is that if you tune a string too high—especially a wound string—and it suddenly breaks, the instant release of torque at the string post can loosen the screw that holds the crown gear to the post. This allows slop between the gears, and backlash can result. This explains why one tuner may occasionally develop tuning problems. You can't repair this, because you'd damage the tuner by trying to get inside it. Your music store, though, can often order a single replacement. Most of the various styles are available from Grover, Schaller, and Gotoh at competitive prices, and they are all equally fine tuners. And don't forget the Waverly W-16 if it's appropriate for your instrument!

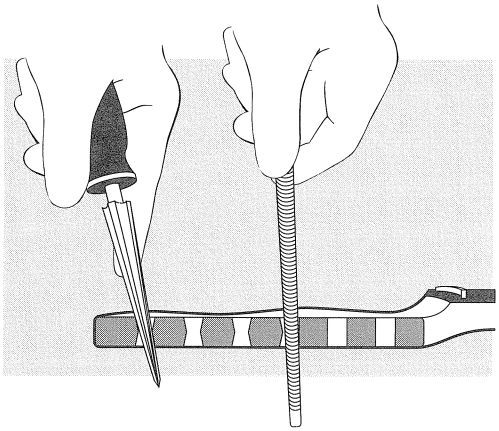
While researching this chapter, I learned that Sperzel tuners are unique. Their construction features totally eliminate backlash, end play, and shaft wobble. Not only are the machining tolerances extremely close, but the string post and crown gear are a one-piece, solid unit that is locked into the die-cast housing by a cleverly machined collar (see previous page). Also, the bushing threads are outside the housing rather than inside, allowing an even tighter fit between the post and housing and further eliminating any play. Since the string post and gear are solid, there is no screw that can loosen. Sperzel has been able to drill up through the shaft, thread it, and install a unique string lock that is adjustable with a thumbscrew from the rear; this Trim-Lock is an option. Another option is staggered post heights for Strat-style guitars, allowing the removal of the string trees while maintaining a good angle for the string passing over the nut. Sperzel tuners are a little more expensive, but they're definitely worth looking into.

Replacing stamped "deluxe" tuners is often simply a matter of removal and direct replacement. Installing die-casts, however, sometimes requires the enlargement of headstock holes. First remove the old tuners and mounting screws. Often the headstock grommets are quite snug, and you may have to rock them out, or at least loosen them by inserting a screwdriver shaft inside and gently rolling it in a circle until you feel it loosen. The grommet can then be pushed out from the rear with a blunt tool. Don't overdo the rolling motion, because you could crack the finish. Now measure the housing's diameter: It will usually be around .380" or close to ⅜", while the original hole will be around 11/32".



This exact hole size would be important if we were going to use a drill, but we aren't; that's for pros or for people in a hurry. Enlarge the hole by using a tapered reamer (available from hardware stores and guitar shop suppliers). Ream halfway through from the front and from the rear, testing often with the new tuning peg until it fits. If the two reamed sides don't quite meet, leave a ridge in the center (above, right), removing this last bit with a rat-tail file. Be sure to hold the reamer at right angles, clean its blades often, and don't be in a hurry. Each hole may take you five or ten minutes. Wrap a piece of masking tape around the reamer's cutting flutes at the correct width of the new tuners to act as a depth stop.

Once all the holes have been cleared and the pegs slip in easily, install the tuners and tighten down the hex-nut bushing against the washer on the headstock's face. Now you can line up



the tuners with the headstock shape in a fashion that both pleases your eye and allows the easiest turning of the keys. When the pegs look right, snug the hex nuts and drill the mounting-screw holes. Use masking tape on the drill bit as a depth guide to avoid drilling through the headstock's face! Be sure to use a bit that's smaller than the actual screw thread, so that the screw can bite into the wood. Thread each screw into the mounting hole to finish the job. The correct way to drill the mounting holes is illustrated and explained in the section on problems caused by over-oiled tuners.

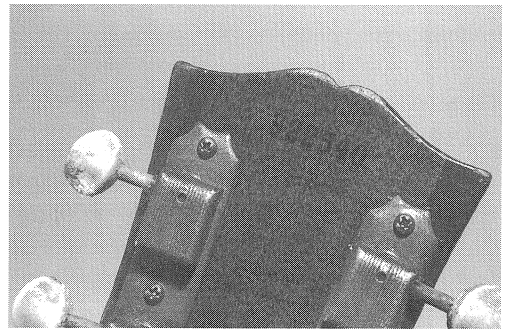
You need to fill the old tuner holes to seal them from moisture absorption and to make the finished job look neat. Remove the tuners to make the job easier. A local guitar shop or cabinet maker can provide small wood scraps (usually mahogany or maple) that match your neck. Carve or file small, round, tapered plugs that are slightly oversize to the hole for a snug fit. Glue them in with a white or yellow glue such as Franklin Tite Bond or Elmer's; use super glue only if you're experienced with it. If you "dry fit" the dowels to each hole, you can see where to trim them to length before gluing them in. This makes cleanup easier and lessens the risk of damaging the finish as you trim. A pretrimmed dowel should push down into the hole until it's flush with or slightly below the surface. Don't expect the color or grain to be a perfect match, and seal the finished plug with a drop of lacquer or super glue as a drop-fill (the section on dents, dings, and scratches explains how). Of course, the plugged holes will be visible unless you totally refinish the headstock, but they should look good enough; besides, that goes along with the installation of die-casts as a replacement for the old-style tuners.

When the finish dries, reinstall the new pegs, put on a new set of strings, and go find someone to play with—you've earned it!

Shrunken heads

Recently I received a note from George Gruhn and his shop foreman John Hedgecoth, warning of a problem that's just beginning to crop up: "We're now seeing an epidemic of deteriorating plastic tuner buttons, pickguards, and body binding on certain guitars built during the early '60s and before." So much for the notion that plastic is forever.

Some plastics used during that era are ticking time bombs with 30-year fuses. The parts most often affected are Kluson "Keystone" and white oval-type tuner buttons; pickguards on older Gibson arch-tops and mandolins; and the pickguards and body bindings on D'Angelicos, Strombergs, Gretsches, and some Epiphones. We are not seeing the same problems with Martin pickguards, for example, or on other instruments that apparently used different types of plastic.



The cause of plastic deterioration seems to be the long-term escape of the solvents and plasticizers used during the manufacturing process (without these, the plastic dries out and crumbles). At progressive stages of this deterioration, the escaping gasses cause fumes that can eat into finishes and wood, corrode surrounding or attached metal parts (turning them green), or exude a sticky, smelly mess that can ruin a clean case. Plastic deterioration may be accelerated by leaving an instrument in a case for long periods of time (not allowing

the fumes to escape), by exposure to high heat, or by a combination of high heat and extreme humidity. Oddly enough, not every tuning-key button on an affected instrument may turn bad.

Solutions for this problem range from complete replacement of the faulty part to repairing plastics that haven't completely disintegrated. John Hedgecoth has found that if the material is still all there for bindings and pickguards, super glues can be used to stabilize the plastic, which should then be sanded smooth and coated with lacquer to seal in the solvents. Bindings that are not too far gone can be masked off and sprayed with several coats of lacquer, since generally only the outer layer of binding deteriorates.

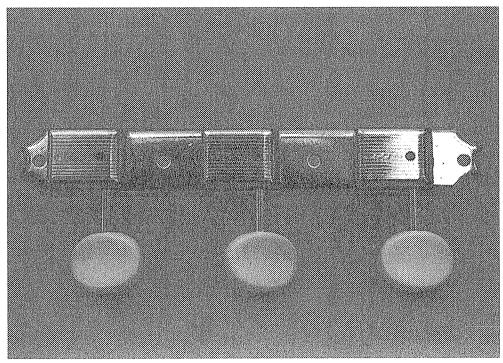
"At the time these instruments were made," Gruhn and Hedgecoth write, "there was no way that the manufacturers could have known that these problems would crop up in the future. With today's synthetics, who knows if we are going to face similar problems 30 years down the line."

The repair or replacement of bindings and pickguards should only be attempted by skilled repairers, so take a problem instrument to the best shop you can find. On the other hand, the replacement of Kluson-style tuners with exact retrofit "look-alikes" isn't too tricky: You just need a small Phillips-head screwdriver. Two types of exact, retrofit Kluson Deluxe-style tuners are available:

- Individual three-on-a-side Gotoh Vintage Kluson-style tuners with single-ring translucent Keystone knobs (as used on Les Pauls, SG's, ES-335s, etc.). These machines feature an improved 15:1 gear ratio and a nylon-bushed worm gear, and they have no name on the back of the housing. They're available from many guitar supply houses, such as W.D. Music Products, Stewart-MacDonald's, Elderly Instruments, Allparts, and C.F. Martin's Guitarmaker's Connection.

- Allpart's Kluson Deluxe Replica "3 x 3 on a strip" tuners have off-white plastic oval buttons, a 15:1 ratio, nylon bushings like the Gotoh, and "De-luxe" stamped on the back (available exclusively from Allparts dealers).

A third Kluson Deluxe-style individual



replacement tuner is available from Schaller, but the grommet is not a retrofit (3/8" instead of 11/32"), and the Keystone buttons are too green for my tastes.

VINTAGE TUNER REPLACEMENT GUIDELINES

- Only replace tuners with exact retrofits. Leave the original bushings intact and use the original screws.

- Remove the rotting plastic buttons from the old tuners. Clean the metal parts, and store them in the case—otherwise they'll get lost!

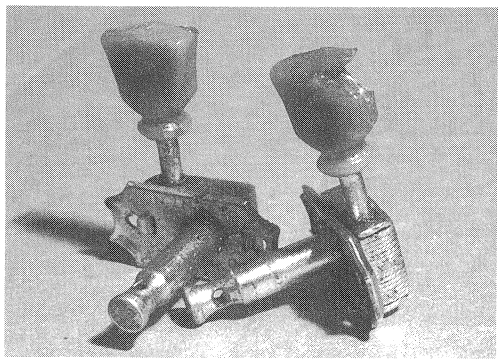
- Replacement tuners often work much better than the originals, but another option is to replace only the buttons on the original set.

- Most important, get the bad plastic out of the guitar case!

There is an alternative to complete tuner replacement. You can repair crumbling plastic buttons or fit new ones onto the original tuners. Read on.

As for "shrunken heads" (the failing plastic knobs on many Kluson-Deluxe tuners from the '50s and early '60s), the simple solution was to replace the entire tuner with easy-to-install, exact-fit replacements. Two Kluson-Deluxe style replacements were recommended: Allparts' three-on-a-strip style with white oval buttons, and Gotoh's individual "Keystone" single-ring tuners. For those who prefer to keep their vintage tuners and repair or replace only the funky plastic knobs, here are some repair and restoration tips.

Crumbling and rotting knobs can often be stopped in their tracks with a bath of super glue. Remove the tuners from the guitar, but if the knobs are really cracked and crumbly, don't even detune them to remove the strings.

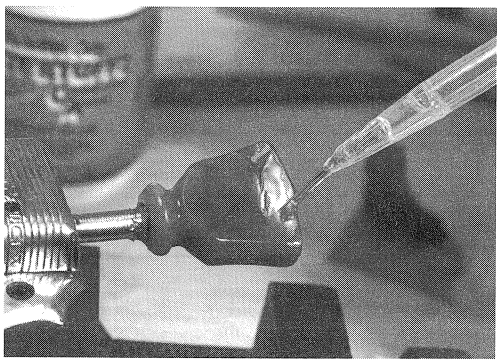


Instead, clip the strings off (wear eye protection to do this), since the plastic knobs may crumble to pieces in your fingers.

■ Clean off all dirt, green corrosion, and goo, first with naptha (lighter fluid). Let it dry, and then use alcohol and let it dry overnight.

■ Dip the knob in water-thin, red-label Hot Stuff Original Formula super glue, going slightly deeper than the plastic itself. Immerse for several minutes, and be happy if you see air bubbles.

■ Remove and drip-dry, wiping off any big drop with a Q-Tip or pipe cleaner.

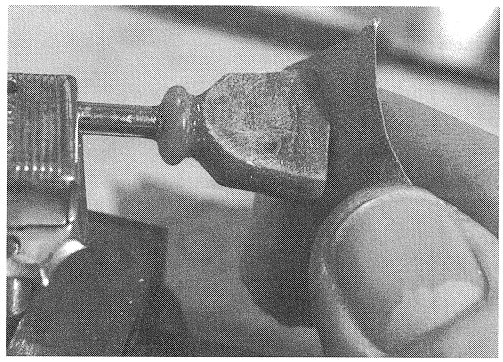


■ Once the super-glue has saturated all the cracks, further fill any other fissures with thicker, yellow-label Super-T Hot Stuff (above). Let dry until hard.

■ For missing corners or chunks, build up layers of brown Fresco powder mixed with baking soda, saturating it with Hot Stuff as you go (top photo, right).

■ Baking soda buildup can be sculpted with files and sandpaper (lower photo, right).

■ Sealed and rejuvenated knobs can be given a final gloss-dipping of super glue, then wet-sanded and buffed.



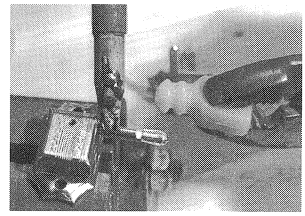
Until replacement knobs became available, we'd "steal" knobs from newer tuners and "loan" them to vintage ones. And for various reasons, one still might prefer to remove knobs and transfer them to a vintage set. For example, Schaller Keystone replacement knobs are too green for my tastes, so I'll remove the nice-looking Gotoh knobs and use them on vintage tuners, even though it means trashing a new set of Gotohs just for the knobs! Or I'll use the knobs from the more recent Gibson De-luxe keys and saw off the extra "ring." But whether you're stealing knobs or using new replacements, the technique is the same:

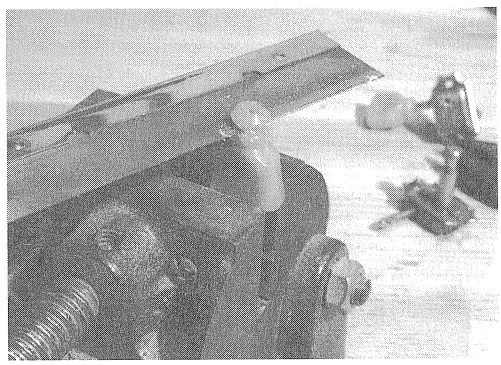
■ Remove the tuners from the instrument.

■ Use a soldering iron to heat the shaft (pictured at right is a double-ring knob from a Gibson De-luxe). Pull on the knob as you heat, and the knob will slide off cleanly.

■ Use a razor-saw to convert a double-ring knob to a single (top photo, next page).

■ Clean and then heat the vintage shaft, and slide the new knob on. If you're "stealing" Gotoh knobs, you may need to deepen the shaft hole with a # 31 (.120") drill bit in order for them to slide far enough onto a vintage shaft; the hole should measure about ½" deep.





■ A drop of super glue on the shaft right where it meets the plastic isn't a bad idea, although it's not always necessary.

The photo above shows some knobs that are repaired, some that are replaced.

Cautions: When working with solvents, cleaners, and super glues, be sure to wear protective gloves and safety glasses, and work in a well-ventilated area. And if you're at all in doubt about doing this work, take your axe to a repair shop!

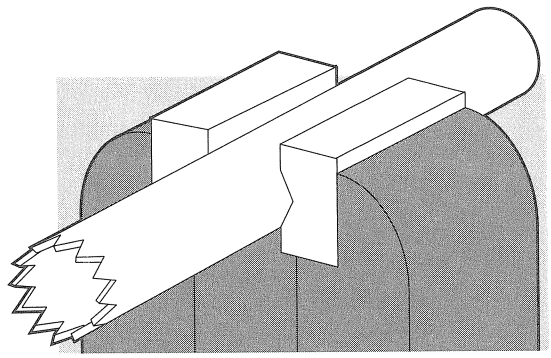
Plastic replacement buttons are available from Gruhn Guitars, 410 Broadway, Nashville, TN 37203 (615) 256-2033, and from Stewart-MacDonald's Guitar Shop Supply, 21 N. Shafer St., Athens, OH 45701 (800) 848-2273.

Removing broken headstock screws

Everyone breaks off the head of a screw at one time or another—even pros. With guitars, it happens most often with tuner mounting screws installed into maple, since maple is hard and the screws are small— their heads twist off easily. If you follow the correct drilling technique for the screw thread and shoulder, you should never be faced with the problem, but don't never say never—I've snapped 'em off more than once when it seemed that everything was going right. Here's a clever trick for removing them, passed on to us by my good friend Paul Warmoth of Warmoth Guitar Products in Puyallup, Washington. It's a combination plug cutter/screw extractor.

At the hobby store, buy a piece of hollow brass tubing large enough to completely surround the broken screw shank and some of the wood that it's embedded into. A 3/16" outside diameter tubing has a large enough inner diameter to straddle the screw because the tubing's walls are so thin. Clamp the tubing lightly into a vice and file small teeth into one end (below). I filed the teeth with a small feather-edge file that's used to sharpen the teeth of Japanese Dozuki and Ryobi hand saws, but any small, thin metal file will do. File the face and gullet of each tooth at slightly less than 90°, and the back or rake at any angle—you needn't be too specific—just so it angles back and away from the cutting edge to eliminate friction.

Chuck your new plug cutter into a hand drill, electric drill, or drill press, and drill slightly past the depth of the embedded screw. Then back



out the cutter and wiggle the plug until it breaks off, which it will do quite easily (or use the cutter—gently, to avoid bending it—to "break" the plug out). The plug that pops out will have the broken screw in it! Now all you need to do is plug the hole with a piece of wooden dowel, and here's how you do that.

The hole you're going to fill is 3/16" in diameter, so whittle and file down a 7/32" or 1/4" dowel. When you get in the 3/16" ballpark, be very careful to keep the dowel round; you'll probably have to try several times, but dowel sticks are cheap. If you have access to lots of drill bits, and preferably a drill press, there's a better way to size a wood dowel to keep it round and get a good fit.

Using a #9 drill bit, drill a hole through a 1/4" plate of steel or aluminum. The #9 bit measures .196", which is bigger by only nine thousandths than the 3/16" (.187") hole you wish to plug in the back of the headstock. File or sand a taper on the end of the whittled-down dowel (which is still slightly larger than 3/16"), and pound it through the hole drilled in the steel plate. The dowel compresses as it's forced through the sizing hole, allowing it to press-fit into the headstock hole when you tap it in. Then it will swell up tight if you glue it in with a water-base glue such as Franklin's Titebond or Elmer's Carpenter's Glue. Note: Whenever you drill steel, aluminum plate, or anything hard, clamp it down! Especially with steel or aluminum, and especially with a powerful tool such as an electric drill or drill press. When the metal binds to the drill bit—and it often does—it can go whipping around fast enough to cut your fingers off, at the very least! Speaking of drills and drill bits, here's some information you may be able to use:

A full set of drill bits (under a half-inch) is called a drill index and has three types of bits: letter bits from A (.234") to Z (.413"), number bits from 1 (.228") to 80 (.013"), and fractional bits from 1/16" (.062") to 1/2" (.500"). These bits allow you to drill almost any size hole. Such a drill index was once out of reach for most of us, costing hundreds of dollars; we repairmen would buy just what we needed at a good hardware store. These days you can find the full set (of a lesser quality, but they're fine) for $49 in almost any mail-order tool catalog.

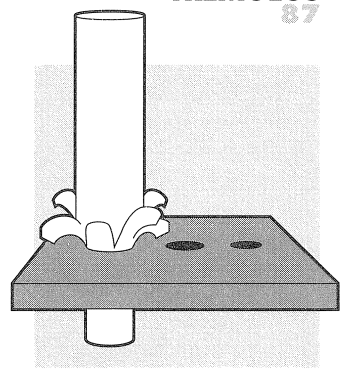
If you can get your hands on a full set of drill bits, try this old-time furniture maker's trick for sizing dowels: drill a series of sizing holes. In our case, start at just under a 1/4", with perhaps a "D" or .246" bit, and drill holes at intervals of ten-thousandths until you get to the #10 (.193") size. The holes will actually shave the wood off as you drive the dowel through the plate, not just compress it!

There's a method here for everyone, so for the well-equipped do-it-yourselfer or the serious professional, here's another way to plug that hole in the headstock if you have access to a metal lathe.

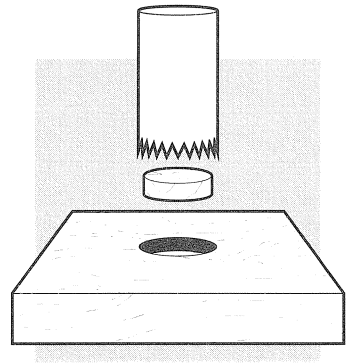
Make two plug cutters: one to remove the screw and its surrounding wood, leaving a 3/16" hole in the headstock (.187"), and the other with a .196" (#9 bit) inner diameter to cut the plug that fills the hole. The smaller cutter is made from 3/16" steel rod, and the larger one from 1/4" rod.

Chuck a 1 1/8" length of the 3/16" rod into the lathe, face it off square, and bore a hole 5/8" deep into the end, using a #25 (.150") bit. Remove the #25 bit, put a 3/32" (.093") bit into the drill chuck, and bore a clearance hole completely through the length of the rod. This is so you can push the plug out later; we used the smaller bit for the clearance hole so the plug cutter would have some strength. File the teeth, and this is your extractor. It will cut a .150" plug around the screw and leave a 3/16" hole in the headstock for you to fill.

Next chuck the 1/4" rod and drill a .196" (#9) hole clear through it (a smaller clear-through hole isn't needed here, because the 1/4" rod has quite a bit more strength). File the teeth, and this is your plug cutter—it will cut a tight-fitting .196" plug. The beauty of this method is that you can cut a plug out of side grain in any scrap of matching wood (maple, mahogany, whatever you have), and the match can be tremendous. Avoid burning your plug, especially in maple, by cutting slowly—these are somewhat crude, homemade bits (and they certainly aren't hardened)! And all this just from a little tool idea that Paul called me with one day.



Whenever you drill steel, aluminum, or anything hard, clamp it down—especially with a powerful tool like an electric drill or drill press!



These measurements aren't set in stone. By going smaller on all the sizes, you can cut plugs that can be hidden by the housing of most tuners. I don't always use Titebond glue, either; often it's Hot Stuff.

If you use hide glue or Titebond, pre-soaking the dowel in water before installation guarantees a tight fit.

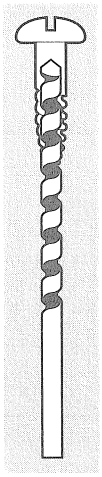
Damage caused by over-oiled tuners

Something that's often overlooked when people are buying or caring for a used guitar is tuning gears that have been oiled too much. Most modern tuners are permanently sealed and lubricated, so they need no oil. However, I've seen hundreds of good guitars with tuners that have been oiled regularly, and this excessive oiling causes three common problems that can be expensive and aggravating.

The first problem is stripped mounting screw holes. The screws vibrate loose after years of playing, and when the owner tightens them, the soft, mushy wood no longer holds the screw's thread. Second, the finish lifts away around the tuners at the rear of the headstock or on the face of the headstock around the shaft hole. Finally, splits occur in the headstock wood itself. The oil seeps under the tuner, down the shaft hole, and into the wood's end grain. This eventually causes the wood to swell and sometimes split, or it may simply rot. Often these problems can be caught in time and aren't too serious. Before you attempt any repairs, the work area on the headstock needs a good cleaning and degreasing.

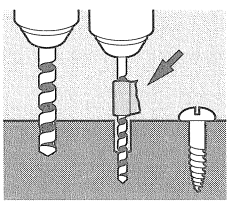
Begin by removing the strings and then the tuners themselves. The holes in the headstock —both the shaft holes and the mounting screw holes—are often swollen and mushy. You can remove much of the grease by packing the large shaft holes with Kleenex or cotton balls. Clean the screw holes with a pipe cleaner. The round, tightly-packed cotton wadding used by dentists is an excellent absorber. Soak up as much oil as you can, and then clean the larger holes with some lighter fluid applied with a rag, cotton, or Q-Tip; use a fresh pipe cleaner for the mounting holes. The lighter fluid helps degrease the problem areas. If you're not in a hurry, leave the holes exposed for an overnight dryout. Clean the tuner housings with lighter fluid also, so they aren't reinstalled in their oily condition. When you've cleaned and degreased these, you can begin any necessary repairs.

The worn screw holes can be fixed quickly and easily with some baking soda and water-thin super glue. After you have cleaned and degreased the worn or stripped hole, fill the hole one-third full of baking soda, followed by a drop of super glue into the hole and onto the soda. The glue and soda harden immediately, usually with a puff of smoke. Don't inhale the fumes or let them get into your eyes! Fill the remaining two-thirds of the hole in the same manner, a third at a time, making sure that the glue saturates all the soda. When you've filled the hole flush to the surface, you can redrill it and know that the screw will hold.



It's important to use the proper size drill bit. It should match or be slightly larger than the screw's shaft, but it should not be as large as the outside measurement of the threads themselves (left). Some screws have a shoulder that is larger than the thread. You may need two drill bits in this case—one for the shaft thread, and one for the shoulder if it extends down through the tuner housing and into the headstock. Take the screw to a hardware store and pick out the appropriate bits. Look for number bits as well as standard fractional bits; number bits are available in a much larger selection, graduated in finer increments. Numbered drill bits ranging from #51 (small) to #44 (larger) are commonly used for tuner screws. Hold the screw against a background light and compare the bit to the screw shaft. You want to see thread on both sides of the drill bit without being able to see the screw's shaft. If the screw has a shoulder, choose a second bit that is slightly larger, to allow for clearance.

This super glue/baking soda technique works great on any stripped holes you are likely to come across, such as those for pickup mounting rings, truss rod cover plates, etc.



When drilling a hole, wrap a piece of masking tape around the drill bit shaft as a depth guide as shown; this is to stop you from drilling too

deep or even through the headstock.

To remedy the second common problem—finish that has lifted from the wood—let a small amount of lighter fluid seep under the finish where it has raised up. Allow it to evaporate and dry for at least several hours. Follow this with a drop of super glue. The glue will run under the finish as you touch the bottle's tip to the loose edge. Hot Stuff's thin, flexible applicator hose is perfect for this delicate work. Press the loose finish onto the wood, using any round, blunt object. If you wipe some wax onto this object, it will be less apt to stick to the finish or to any glue that squeezes out. Never use your finger! Don't use much super glue, and don't try to wipe off any excess. When the glue has dried (usually in a minute or two) you can remove the bead that may have squeezed out at the edges by carefully chipping it off with a sharp, pointed tool; a needle or pin will do. You may be wise to practice first on yardsale specials or a piece of old furniture.

The final problem, splits in wood, should be dealt with by a qualified repairman. If you've noticed any serious separation of the wood at the headstock, get a pro's opinion. Regluing or filling a crack is usually inexpensive, and I advise you not to do this yourself.

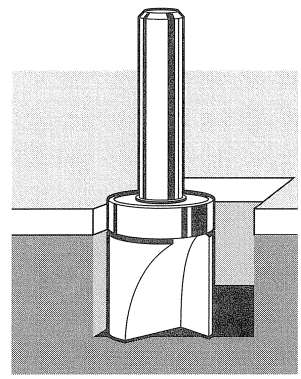
To avoid these tuning-gear problems, use the proper lubricant. For the time when it is necessary to sparingly lubricate a stuck gear, use a powdered graphite or the new space-age lubricants such as Magik Guitar Lube, which have microscopic Teflon balls suspended in a solvent that evaporates quickly, leaving no oily film. A dab of Vaseline often works wonders. In most cases, the stuck tuner is an open-back, non-enclosed type. The gears are visible, so make sure that the parts aren't stripped or cross-threaded. If the gear looks worn or damaged, ask your local repairman for spare parts—most repair shops save boxes of old gears and can match parts easily.

Installing the Floyd Rose tremolo

Fitting a guitar with the Floyd Rose Tremolo and its partner, the locking nut, is work. This section begins by presenting the basics of installing a stud-mount, knife-edge tremolo. We'll cover installing the locking nut separately, and then explain setting up and fine-tuning the unit as a whole. If your tremolo is already installed, don't go away—there's something here for everyone!

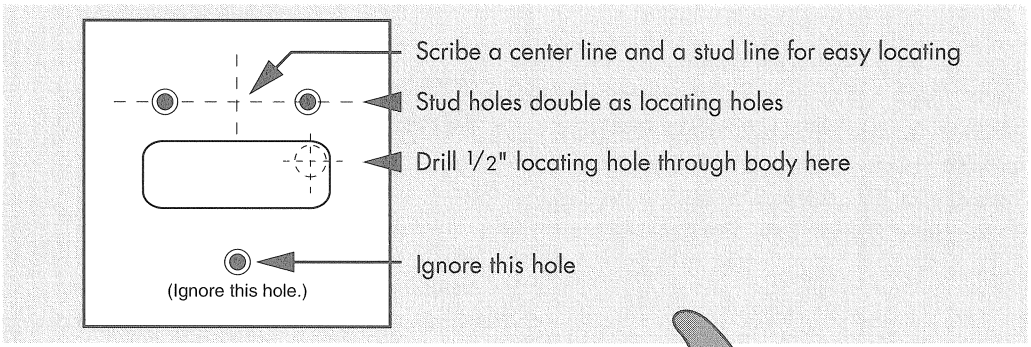
While making a videotape on tremolo installation and setup, I designed a set of related jigs and templates that require simple, clear instructions. Here are those instructions in abridged form, and I'll read between the lines for you, offering additional tips as we go along.

Routing templates and ball-bearing router bits make tremolo installation fairly simple. The body cavities are routed by using Plexiglas templates mounted to the guitar's face or rear; these templates are screwed to a guitar's existing holes—i.e., pickguard, pickup mounting ring holes, etc.—or held with double-stick carpet tape. Specialized ball-bearing router bits follow the templates' pattern (see illustration at top of the next page). The bearing and router bit are the same size, so the cutter trims flush with whatever the bearing rolls against. Routing templates and ball-bearing bits are available from W.D. Pickguards and Stewart-MacDonald.



Typical installations involve either a modified rout for guitars with an existing standard Strat-style tremolo (the cavities need only to be enlarged in certain places); or a full rout for guitars that never had a tremolo, for custom-built guitars, and many kit bodies. The same rout depth, width, and clearance measurements used for the full rout apply to the modified rout as well. We'll start by describing a full rout, using the templates mentioned above.

The clear Plexiglas top-rout template is most easily placed if you scribe locating lines on its underside. Scribe a line laterally, when looking at the guitar, through the centers of the two

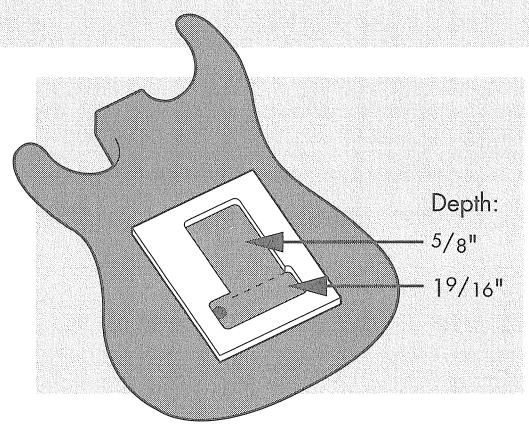


mounting holes (right), and then scribe a second line at right angles to it, centered exactly between the holes. This second (longitudinal) line will correspond to a center line taken from the neck and laid out on the body. To find center, use a finely graduated rule and mark the center of the fingerboard at the nut and the last fret. With a long (30") straightedge resting on those marks, transfer the line onto a piece of masking tape fixed to the top in the area where the tremolo will be located. A taut piece of string (and a friend to stretch it) will work if you don't have a long straightedge.

Now locate the template on the guitar top with line B on the guitar's center line, and with line A located the correct distance from the front of the nut. (Exact measurements for the bridge-stud center line measurements are given at end of this section.) Mark exactly the two template mounting holes onto the guitar top; these should be 2 15/16" apart, or 1.465" to each side of the center line. Drill the mounting holes with a 7/64" bit, and use #6 x 1" drywall screws for fastening. The holes must be perpendicular to the top, since later they'll be enlarged and used for the pivot-studs.

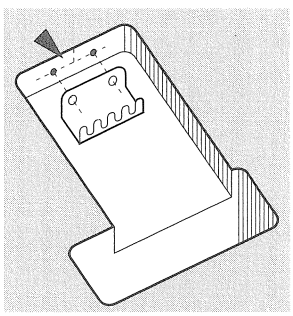
Screw the top template onto the body and measure 1/4" from each edge of its top right corner, marking this location with a center punch. Remove the template and, using a drill press and brad-point drill bit for accuracy, drill a 1/2"-diameter hole here, right through the body. This hole aligns the front and rear templates (the modified rout skips this step).

Remount the template. You're ready to rout, using a 3/8" ball-bearing bit. Eliminate plunging into the wood by starting each routing pass with the bit in the 1/2" locating hole drilled earlier. Rout the front 11/16" deep, but go slowly—no more than 1/4" per pass. The first rout is deeper than the others since, for the bearing to contact the template, the bit's full 1/2" cutting length must make the first pass (unless you shim the template up 1/4" to get started, which is a good idea). Once you're 5/8" or more deep, remove the template (its thickness might keep the bit from going to 11/16"). The bearing will follow the routed wall just created. Tape paper over the finish to avoid scratches from the router base plate. Stewart-MacDonald offers long-shaft bearing bits that permit chucking more shaft into the router collet—a safety feature I like. Never rout with less than 1/4" of safely chucked shaft on the router bit!



The rear template mounts by aligning one corner over the pre-drilled 1/2" index hole (above). Square up the template lengthwise to the body. Drill mounting screw holes or use double-stick tape to attach it to the guitar.

Rout the entire inside shape of the template to a depth of 5/8". The rear rout will meet the front rout. Now the spring cavity is complete. Continue routing inside the template to a depth of 19/16" for good tremolo clearance. The rear template can now be removed. Center the tremolo-spring claw on the front wall of the rear cavity, with its two holes 3/8" from the back of the guitar (drawing at left). Mark the holes and



drill them with a long ⅛" aircraft bit.

Return to the guitar top, and redrill the two mounting holes 1¼" deep with a #10 bit; this is for the threaded portion of the mounting stud. Next, drill the holes again with a letter "I" bit, but only ⅜" deep. This hole gives clearance for the stud shoulder; it's a close-tolerance fit, since it supports the shoulder during use. Install the studs. Note: Press-in anchor inserts with machine-thread pivot studs are now available as a substitute for the original wood-thread studs. These eliminate wood fatigue and the loose studs that can occur with prolonged tremolo use.

The studs, tremolo, claw, and springs could be installed now, but without the locking nut and strings, what's the use? Hold on until we get the nut on, and then we can play a few tunes.

Here are the mounting distances for five popular tremolos, measured from the nut's front edge to the center of the pivot-stud line. Figures for both long and short scales are given. A common installation error is to install the tremolo too far from the nut, causing the guitar to play flat or the bridge saddles to hang over the unit's front edge. You'll be safe with these figures:

Tremolo	25 1/2" Long scale	24 3/4" Short scale
Floyd Rose	25"	24 3/16"
Schaller Floyd Rose-licensed	24 15/16"	24 1/8"
Ibanez Edge	25 1/16"	24 1/4"
Kahler Spyder	25"	24 1/4"
Gotoh Floyd Rose-licensed	25"	24 1/4"

MOUNTING THE LOCKING NUT

Now that you've installed the Floyd Rose stud-mount tremolo, continue by getting the locking nut on. Once you can lock the strings at both ends, your tuning troubles are over.

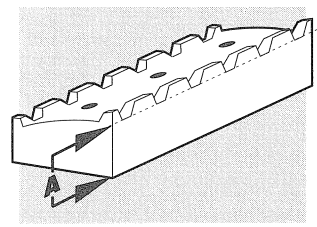
When we shot a videotape on Floyd Rose installation at Stewart-MacDonald, I was worried about how I'd teach the nut installation so that it could be done with simple tools such as a router. (I'd been doing my installations on a vertical milling machine.) I actually dreamed up the following method right during the shoot, and it works better than I would have guessed at the time! Stew-Mac now sells this jig, and if you plan to do more than one of these operations, or perhaps to get into the business, it would be a wise investment. It's inexpensive and comes with extremely detailed instructions, and you'd need a machine shop to build one as accurate. But for one-time do-it-yourselfers, here are the jig instructions in abridged form, with illustrations to help you fashion your own router jig.

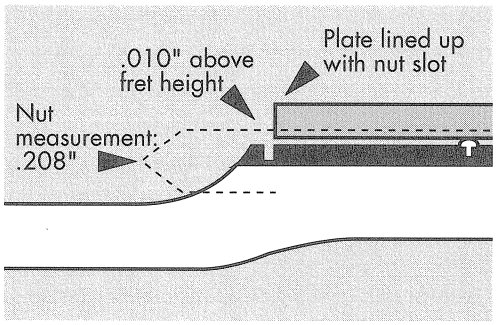
Even with locking tremolos and nuts, you'll still have some kind of tuning problems. Nothing's perfect when you're dealing with guitars. Don't forget to enjoy playing!

The installation consists of cutting a ledge for the nut to sit on by removing a predetermined amount of wood where the original nut was installed. Then, holes for the nut's mounting bolts are drilled and countersunk. In an experienced woodworker's hands, a sharp chisel could cut the ledge quickly and easily, but a novice should use a Dremel Moto-Tool to slowly machine it. You players who are serious enough about guitar repair to install a locking nut yourselves should welcome an excuse to add a Dremel router to your toolbox.

Installation with chisel or router requires that you accurately measure the depth of the ledge, so that the nut ends up at the right level with respect to the frets. Having it too low causes buzzing, while having it too high creates a stiff action. A pair of dial calipers that measure in thousandths of an inch are a real help. Plastic-bodied dial calipers can be purchased for around $20—another invaluable addition to the tool chest.

When the outer two *E* strings are .010" above the height of the frets as they sit in the bottom of the nut slots, you're in the right ballpark. This is an average, slightly stiff playing height. You'd seldom want a higher action, and you can lower the nut if it feels too stiff. To rout the correct depth, you need one measurement: the distance from the locking nut's string-slot bottoms to the bottom of the unit itself ("A" at right). The nut described here is a Schaller R3 Floyd Rose-licensed model with an "A" measurement of .208". (Floyd Rose and Schaller designate neck/string spacing width with numbers ranging from R1 to R6; they're all slightly different at the "A" measurement.)





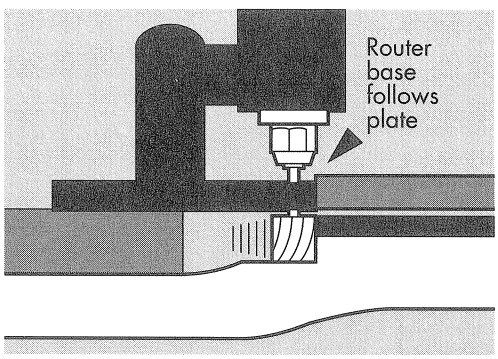
Here's how to guarantee that the nut-slot bottoms end up .010" higher than the fret height.

MAKING THE JIG

Clamp a flat, uniformly thick plate of wood, metal, Plexiglas, etc., to the first two frets, with its front wall flush to the original nut slot (above). Now, the bottom of the clamped plate is level with the fret tops, so if you use dial calipers to measure .010" short of the bottom, that's where you want the nut-slot bottoms to end up. Next, add the one nut measurement we took (mine is .208", yours could be different), and you'll have the distance from the top of the clamped plate to the nut bottom; this is the ledge to be routed.

The plate is more than a surface to measure from, however. With its front edge in line with the nut slot, it acts as a "fence" to guide the Dremel router base, keeping it from cutting into the end of the fingerboard. And routing the end of the fingerboard would change the overall string length—a disaster! The locking nut's front should be flush with the fingerboard end, with the nut bottom at a 90-degree angle to it.

Complete your installation jig by clamping a second platform of uniform thickness to the headstock face. This raises the Dremel Moto-Tool above the surface to be routed, allowing the cutter to be lowered into the wood by



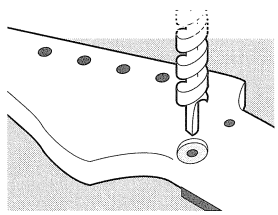
degree. You now have a usable facsimile of the jig I made, which is a single unit made of clear Plexiglas (the upper and lower plates are joined with threads and cap screws). The lower plate has a routing hole machined into it, and a built-in clamp holds it to the neck. There are two types of headstock: the straight, Fender style, and the angled, tilt-back Gibson type. With either, you remove the tuners in order to clamp on the platform (for the tilt-head, shim the table level with the fingerboard).

ROUTING

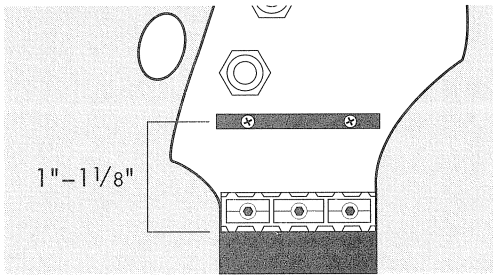
Use only a #115 Dremel router bit for the cutting. Rout no more than 1/16" per pass, and be sure that the bit cuts flush with the router's base edge. If the bit cuts more than flush, it could trim the fingerboard end. (If this happens, loosen the two mounting screws and wiggle the base into line, or put a couple strips of masking tape along the base edge to shim it away from the fingerboard).

Measure often from the top plate as you rout, and when the ledge is cut, lightly glue the nut body (with string clamps removed) to the ledge. Spray Hot Stuff accelerator on the nut bottom and put two small drops of Hot Stuff Special T super glue on the newly routed ledge. Thirty seconds' drying time will set the nut firm. Then use it as a drill guide for a #30 drill bit. Using a layer of wax paper in between, place a hunk of modeling clay under the rear of the neck/headstock area and press the neck into the clay to form it. The clay supports the wood, allowing your bits to punch through with no splinters! Drill down through the two mounting holes, right through the neck—the nut will hold the bit square. Now tap the nut loose using a block of wood and a hammer. Enlarge the #30 holes with an 11/64" bit, again drilling from the top side.

The countersunk holes are most safely drilled by using a step-bit. Stewart-MacDonald makes a step-bit with an 11/64" pilot to follow the 11/64" hole drilled earlier, and a 5/16" outer bore that drills a shallow flat-bottomed hole for the bolt heads. Extra care must be taken to avoid the bits' grabbing or



tearing the wood by accident. From the rear, countersink the holes until three or four threads protrude through the ledge when the bolt is inserted. This is plenty to hold the nut tight—any more, and the bolt could come through the locking nut's top and touch the string clamps. Go ahead and mount the nut. If your nut ends up too low, it's common to shim it up to the right level. Good shim materials included 3M wet-or-dry sandpaper in the 400, 600, and 1200 grits, or mesh-like drywall sandpaper with a good grip (check your lumberyard).



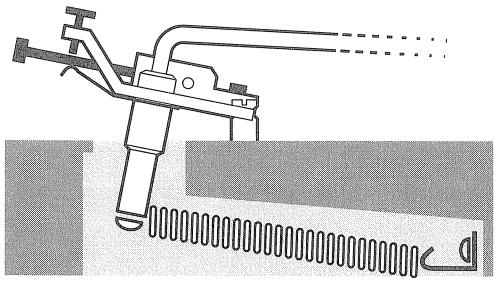
Last of all mount the retainer bar. Locate it 1" to 1⅛" from the front of the nut, and centered from side to side as at right. Drill the two screw holes with a 9/64" bit marked with masking tape—this provides a visual depth stop to prevent drilling through the headstock! Put your strings on, and check your work. You're done with the worst part. Now we'll troubleshoot any problems, cover setup and fine-tuning, and look at the recessed top-rout made popular by Steve Vai and the Ibanez Jem 777.

Setting up the Floyd Rose

Now you can relax, since the job of setting up your tremolo is easy if you learn these simple set-up basics: Level the tremolo to the body by adjusting the springs and spring claw, set the string-to-fingerboard height by adjusting the two pivot studs, and adjust the intonation. Guitar Player magazine ran Mark Lacey's "Fine Tune Your Floyd" in its Sept. '88 issue, and I suggest you read it; your library probably has a copy. Action and intonation are discussed in the earlier chapters of this book, so I won't bore you with repetition. I'll just skim through the simple stuff, making a few important points as we go. This will leave some space to take a look at the optional recess rout made popular by Steve Vai and the Ibanez Jem 777 series.

Leave the locking nut unclamped while you do the following work. First, level the tremolo parallel with the body by adding or removing springs in the rear spring cavity. Using a Phillips screwdriver, adjust the spring claw in or out until the unit is level. Most players use either two or three tremolo springs for string gauges beginning with .008 or .009, and usually three for .010 and up. Experiment until you get the right feel. Next, the string height from the fingerboard should be set before adjusting the intonation. Most players look for a low action that shows around 1/16" between the bottom of the strings and the top of the 12th fret. However, most players settle for a slightly stiffer action than this—say, 3/32". How low you can go depends on the adjustment of the neck and the condition of the frets.

Set the string height by simply raising or lowering the two pivot studs that the tremolo mounts on; this is much easier than with the individual saddle height adjustments common to Strats and many other guitars. Unless your tremolo uses machine-thread studs that adjust with an Allen wrench, use a flat-blade screwdriver with a sharp, well-ground tip that fits the stud slot snugly. This eliminates slippage that can not only mar the slot, but also cause the



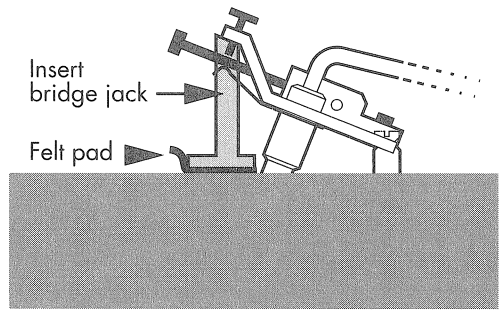
You may need extra clearance in the spring cavity (exaggerated here). Note the tapered back wall: the shallow end may be $^{5}/_{8}$" to $^{3}/_{4}$", while the deep end may be $^{11}/_{16}$" to $^{13}/_{16}$".

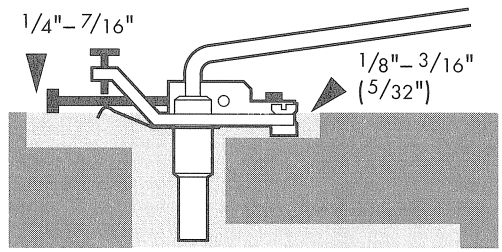
plating to lift away. As a general rule, most players adjust the tremolo so that the underside is from ⅛" to ¼" off the face of the guitar; this provides plenty of forward dump and a fair amount of up-pull.

Keep in mind that a tremolo set close to a guitar's face has little clearance in the rear for up-pull on the bar. A tremolo that's set high off the top may require shimming the bolt-on neck to keep the strings close to the fingerboard (for advice on neck shimming, see the bolt-on neck section of Electric Adjustments). Also, a high-set tremolo may seem uncomfortable for players accustomed to resting their picking hand on or near the body (one solution, the recess rout, is explained later). And, depending on the cavity depth, a tremolo that's mounted high off the body may cause the springs to rub the bottom of the spring cavity. Ibanez and Kramer use a tapered cavity to solve this problem (first drawing, top of next page).

Floyd Rose saddles are made in three different thicknesses or heights. The tallest is used for the *D* and *G* strings, the medium for the *A* and *B*, and the shortest for the two outside *E* strings. This saddle-height combination creates a curve in the bridge saddles that matches the radius curve of most electric guitar fingerboards. Many players find that the "medium" saddle curve of the Floyd Rose plays comfortably with most necks. Custom-tailoring the saddle height is possible by shimming the inserts with thin metal shim stock available from most automotive suppliers, or by carefully grinding the bottoms of the saddles to alter their height (this grinding is a tricky operation and should be left to a professional!). If you wish to experiment, replacement saddles are available directly from Kramer.

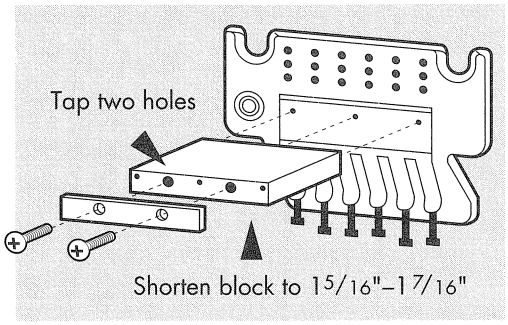
Setting the intonation of the Floyd Rose bridge saddles works on the same principle as any other adjustable bridge—if a string notes sharp, move the saddle back away from the nut;





if the note is flat, move the saddle forward toward the nut. Since the string is clamped into the saddle itself rather than into a separate tailpiece, the saddles tend to slide forward from string pressure when you loosen the Allen bolt that holds them in place. This can be annoying if your intention is to move the saddle back, since you have to loosen (detune) the string in order to do so. Try "dumping" the bridge forward and inserting a bridge jack (above, right) to hold the tremolo up, keeping the strings slack while moving a saddle back or forth. I made my jack out of two scraps of hard maple and covered the bottom with felt as a protection for the finish. Of course, an electronic tuner is a help for setting the intonation. When your setup and intonation are correct, clamp the locking nut tight.

Here are a few tips on recess routs, which involve the removal of wood under the tremolo (below the surface of the guitar face). This allows the tremolo to sit fairly close to the top ($^{1}/_{16}$" is common) while still having clearance in the rear for up-pull. Also, many guitarists keep their palm, hand, or entire arm on or close to the top while picking, and the recess rout keeps the bridge closer to the body for this type of picking comfort. Recess-routing templates are available from some guitar shop suppliers. Most recesses are from ⅛" to $^{3}/_{16}$" deep in the front portion of the rout, and deeper (¼" to $^{7}/_{16}$") toward the rear for up-pulling (above). Since you can always rout deeper, start with the shallower measurements and follow the ball-bearing routing techniques described earlier.



Recess routing may require shortening the tremolo block to keep it from sticking out of the guitar's back. The amount you shorten it depends on how close to, or deep into, the top you want your tremolo. The Ibanez Edge block measures 1 5/16", while Kramer's shortened block for their guitars with factory-equipped recess routs measures 1 7/16". I shortened the block on my Floyd Rose-licensed Schaller to match the Ibanez Edge tremolo. Here's how to do it:

With a 1/16" drill bit, deepen the five spring holes by the amount you plan to remove (up to 3/8"). Using a hacksaw, remove up to 3/8" from the block's bottom, and then file it smooth to a length of 1 5/16" or 1 7/16", etc. Drill and tap the two spring holes on each side of the center-spring hole to accept a machine screw; I used a 10-32 truss-rod tap that I had handy. Finally, make a 1/8" x 2" x 5/16" flat spring retainer bar (1/8" screen-door aluminum stock purchased at the hardware store and hacksawed and filed to shape) with two clearance holes for mounting the bar to the tapped holes in the block. This will keep the springs from popping out when the tremolo's in use, especially on up-pulls where the springs go slack.

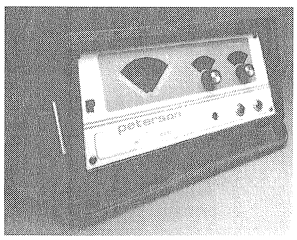
Well, that's about it for the Floyd Rose tremolo. For more information, read Mark Lacey's feature and check the Mar./Apr. '88 issue of *String Instrument Craftsman* for Chris Piles' article on Floyd Rose setups.

Kahler installation and setup

I chose the Floyd Rose tremolo to teach measuring, layout, and routing basics; not only because it's popular, but because it's the hardest to install. If you can mount a Floyd, you're good with a router and can definitely handle any other installations. The most popular and readily available tremolos on the market are the Floyd Rose, the Schaller-licensed Rose, and the Kahler flat-mount. The last section covered installing the stud-mounted "floating" tremolos; now watch how you can apply those same skills to installing another excellent and popular tremolo: the Kahler 2300 series, cam operated, flat-mount tremolo. The 2300 series is the original Kahler tremolo that became popular in the early 1980s.

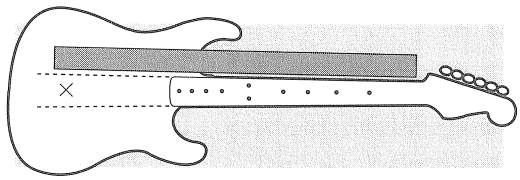
Several features set the Kahler apart from stud-mount "floating" tremolos. It requires a much smaller body rout (removing less wood, and therefore less mass), and the rout doesn't need to go clear through the body, since it doesn't use a rear-rout for tremolo springs. Instead, the Kahler achieves its smooth operation by way of two small factory-installed springs, ball bearings, and a cam. Not having to rout clear through the body makes for an easy, good-looking installation on bodies that have never had a tremolo before, such as Gibsons, hand-made guitars, Teles, etc. Here's how the Kahler's installed, but first a word of advice before you turn on that router.

My friend and one-time apprentice Charlie Longstreth helped me compile this Kahler information, and he emphasizes a good point: "The first question that should occur to anyone about to install the Kahler or any other tremolo is: Should the installation be done at all? It'd be tragic to modify a pre-CBS Strat, and many Kahlers are mounted on Strats. If you're lucky enough to own one of those rare birds, pick up a newer Strat and put a Kahler on it—and even then, remember that Strats that are new now will be old someday. Maybe you should build a guitar from kit parts." Okay, let's begin.



You'll find that an electronic tuner is a big help when you're setting the intonation.

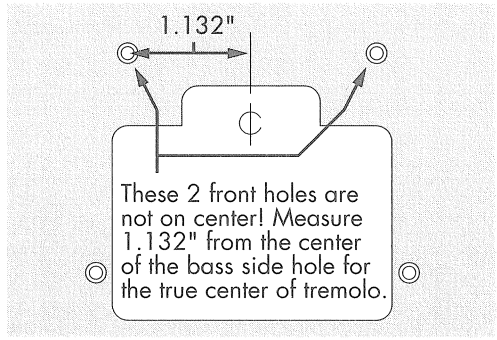
While Kahler makes a version of its famous flat-mount tremolo that can be installed on the tailpiece studs of a Gibson ES-335 or Les Paul, we'll use the Strat-style guitar for this installation. First, be sure that your neck is lined up to the body the way you want it, especially with reference to the bridge and pickups. Read the section on bolt-on necks carefully, and then remove any parts that could get in the way of your router, such as the pickguard, pickups, bridge, and the volume and tone controls. Next lay a strip of masking tape over the six factory bridge mount holes, and lay out the center line of the body using the same method described for the Floyd Rose. Another way to find center is to use a straightedge long enough to lay along both sides of the fingerboard and extend out onto the body as far down as your masking tape. Mark the straightedge line on the tape and find the center between the two marks.



With each tremolo, Kahler supplies a heavy cardboard template to use as a guide for laying out the area to be routed and to locate the mounting screw holes. To ensure correct lengthwise placement and good intonation, this template is located on a line measured out from the nut and marked at right angles to the body center line. Note: This cardboard is not a routing template; it's only for locating the tremolo. If you're using a Plexiglas routing template, the cardboard piece can be omitted, since the Plexiglas template will work for the layout as well as the actual routing.

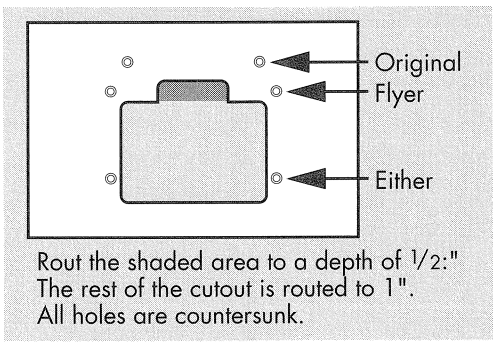
The front two mounting holes in the baseplate of the Kahler flat-mount 2300 bridge (and the layout templates) are intended to line up with, and screw into, the outer two mounting holes of a standard Stratocaster bridge. You can mount the bridge this way, but if you do, the roller saddles will not be centered with the center line of the neck (and more importantly the strings). The saddles will be closer to the treble side than they are the bass side because the center line of the two mounting holes is not the center line of the roller saddles! I'm unsure why Kahler designed it this way, and it's not way off, but there is a difference of a healthy 1/16" at the saddle. To avoid problems, lay out the correct center line of the saddles onto the template and then center to the neck's center line—ignoring the original Strat mounting holes. Here's how to do it right:

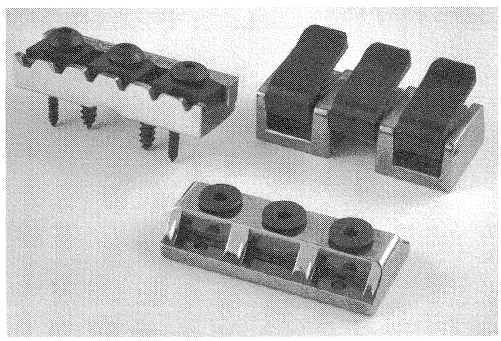
All the instructions I've seen for installing a Kahler recommend marking a center line on the template between the two front mounting holes and then centering the template on the guitar. Ignore that incorrect center line and make a new center line on the template which is 1.132" from the center of the bass side hole—not between the two holes.



When you center the template onto the body's center line, the original outside two Strat mounting holes will not line up. They'll be close, but not right, so plug the two holes and redrill them. (Or you can use the two rearmost holes at the back edge of the template to locate the bridge laterally, because they are centered to the bridge saddles). In either case you'll still have to plug the original Strat mounting holes if you want to be perfect. I had the wrong bridge centering information in the first edition of this book, and I apologize. My error was pointed out to me by Koenraad Strobbe, a repairman in Belgium. Thanks, Koenraad!

Three other considerations when trying to center the Kahler correctly on a traditional Strat are: 1) The pickguard may have to be trimmed on either side of the tremolo. 2) When the tremolo is lined up properly, a small bit of the original tremolo rout may peek through on the treble side. 3) Really, the above centering information is the most helpful for those about to install a Kahler on new work—where there's no good reason not to center it correctly in the first place.





So on a Strat you can: 1) plug the holes, line the template on the body center line, and redrill the holes, or; 2) go with the two factory holes and ignore the center line you laid out. The safest way to guarantee an accurate placement is to ignore any pre-drilled holes and measure yourself. Here's some help:

To correctly place the Kahler in regard to the string length, measure from the nut's front (where it meets the fingerboard) down to the masking tape on the body, drawing a line at right angles to the center line. This new line is for lining up the two mounting holes of the template; later these holes will be used to mount the actual tremolo, since they're the same holes. If the original Strat tremolo mounting holes don't line up with this line, plug the outer two and redrill them. For a long Strat scale (25 ½"), measure 25 ¼" from the nut. For a short (24 ¾") Gibson scale, measure 24 7/16". Once you've located this line, attach the routing template to the guitar body using double-stick tape, or screw the template to the guitar's face with wood screws. The Stew-Mac template that I use (above) has countersunk mounting holes and can be used for either the Kahler Flyer or the Standard flat-mount. The front two holes are for the Original, and the rear/front holes are for the Flyer; the back holes are the same for either tremolo.

Mount the template with wood screws that are smaller than the final mounting screws, and make sure their heads are recessed and won't interfere with the router. After the template is mounted, scribe around the finish along the inside edge with a sharp scribe or X-acto knife. You'll be routing right up to this line, so scoring the finish first helps prevent chips when you remove the template.

Now I can take a break, and you can work. The routing's easy; just follow the directions given a few pages back for the Floyd Rose. The overall depth of the Kahler rout is 1", although many of us prefer to rout only ½" deep on the front part (the shaded area at left, which gives clearance for the two springs) to avoid taking away unnecessary wood, mass, and tone. When you've routed the cavity and vacuumed up the chips, lay a couple coats of clear lacquer on the bare wood to seal out moisture; you can even do this with a rag or a brush. If you want to get fancy, you can tape off the area and spray the new cavity with a matching paint. Sometimes I use black Magic Marker to darken the rout before the clear lacquer. That way, any part of the bare-wood cavity that you could see from the outside can no longer be seen. If your guitar requires a ground wire mounted to the bridge, run that wire now (on new work, you may have to drill a long hole from the tremolo rout to the control cavity, using a long 1/8" "aircraft" bit). You can get an adequate ground simply by screwing the tremolo base plate down onto a ground wire bent up the side of the cavity and wrapped over the edge. Keep this wire away from the workings of the tremolo! Go ahead and install the tremolo now, just to see how everything lines up, and then go on to the locking nut. But don't start playing with that wang bar yet!

Kahler offers the three nut styles shown above, plus one for their 7-string tremolo (not pictured). Two of them, the original Standard and the Deluxe no-wrench, flip-lever nut, are behind-the-nut locks that work together with a real nut. The third is called a Nut-Lock and is similar to the Floyd Rose, which requires that a ledge be routed for installation. We've already

covered the Floyd style, so let's briefly discuss installing the behind-the-nut style; it's easy.

With a Strat, the only real work involved is in making a shim to support the nut at the proper height for getting good string angle through the nut slots. As with any nut, too steep an angle causes string binding or breaking in the slots, while too shallow an angle allows the strings to flop around, causing buzzes. Kahler recommends a string angle of 11 degrees between the string lock and the real nut; check this angle with a protractor.

Make the shim from a hardwood such as maple, rosewood, or ebony. Trace around the nut for the outside shape, mark the holes, and then drill them before shaping the shim; this eliminates splitting the delicate shim once it's shaped. Kahler offers pre-shaped and drilled Polystyrene shims that come in two shapes: a flat shim .068" thick (part # 8450), and a curved-bottom one (#8460) that measures .068" at the thickest part of its center but tapers quite thin at the edges of the bottom curve. In certain situations you may wish to stack different combinations of these shims together. The string-lock should be as close to the real nut as possible, while still keeping the right amount of angle to hold the strings in their slots (about ¼" to ⅜" from the rear of the nut). Too much distance between the lock and the real nut tends to store more slack than necessary. To keep from going clear through the headstock, use masking tape wrapped around your bit as a depth guide while drilling the four mounting holes (this is illustrated in the section on over-oiled tuners in Miscellaneous Repairs).

If you pick with a strong attack and are looking for big sustain, you may be interested in recessing your Kahler into the body. John Suhr, of Rudy's Music in New York City, inlays (or recesses) a Kahler flat-mount 5/32" deep into the body. This allows you to raise the roller bridge saddles to their highest point in order to get a strong string angle over the roller (saddle), without having overly high action. As a general rule, Kahler recommends setting the bridge saddle roller height so that a minimum of .475" and a maximum .625" shows from the bottom of the outer two *E* strings to the guitar body. With the recess method you get the maximum height (and more if you want), but still retain a normal string-to-body relationship, avoiding the necessity of shimming the neck in the body to keep up with the high rollers. Raising the saddle rollers really high creates better response and tonal quality, but the trade-off is more variance in tuning because you introduce more friction to the rollers with the increased string angle. This doesn't bother most players, though, so try it!

Note: If you recess the tremolo 5/32", you must move the bridge forward 3/32", since as the rollers are raised they also move backward—away from the nut—increasing the string length (just raise a roller saddle up and watch how much it moves). An alternate to recessing the Kahler is to raise the saddles high and then shim the neck to meet the strings; of course, the pickups have to be raised, too, and sometimes you just can't get them high enough. I should point out that Kahler doesn't recommend setting the saddles this high. There's nothing wrong with trying all these different setups and deciding for yourself; that's the whole idea of this book!

Kahler includes a pamphlet called Adjustment And Setup with each tremolo; it does a good job of teaching you how the tremolo works. They've also published a "Trouble Shooting Guide" and "Service Tips and Adjustments." Even if you're not experiencing any trouble, ask your dealer to get you copies of these pamphlets, because they'll come in handy some day. For additional reading on Kahler tremolos, check John Carruthers' columns in the Feb. and Mar. '84 issues of *Guitar Player* and read Chris Piles' setup tips in the May/June '88 issue of *String Instrument Craftsman.*

Fine-tuning a Strat tremolo

With its slab-style body, bolt-on neck, and "automotive"-style construction, the Stratocaster is easy to work on from the repairman's point of view—there's nothing to break! How often have you seen a Strat with a broken peghead?

And even though the "Ten Steps" is an excellent approach for basic Strat setup, there are still a few points I'd like to make which are particular to Stratocasters. Understanding Strat quirks and knowing a few tricks of the trade can be a great help in adjusting your guitar for maximum playability.

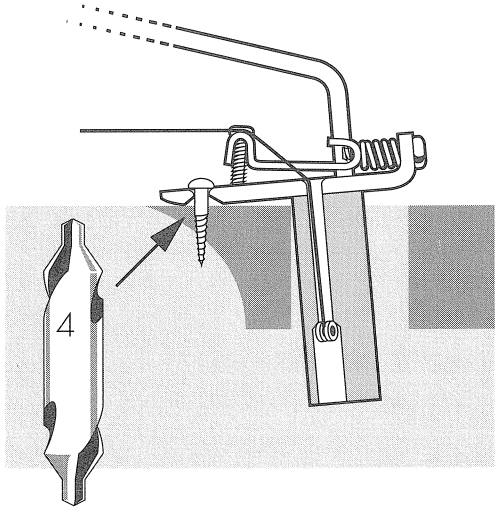
TREMOLOS

Tremolos have been the rage since the early '80s, when Floyd Rose hit the guitar world with a locking nut and string-clamp "floating" tremolo system which eliminated most of the tuning problems long associated with tremolo use. Still, for many, the most desirable tremolo is that used on the Fender Strat—especially the two-piece unit made from '54 until late '71. Fender has introduced several Strat tremolo designs since then (most notably the "American Standard"), and when used with a properly set-up nut, they all work well. The nut is where most tremolo problems occur, as we'll see in a moment. So if you're a traditionalist not wanting to disfigure your favorite axe, you may wonder, "How can I keep my vintage Strat playing in tune, without installing a locking nut and modern bridge?"

I spent some time with my friend Doug Phillips, a guitar repairman from Norfolk, Virginia, who is a Strat man all the way and a serious blues player. I was impressed by his four unaltered Strats that play beautifully and stay in tune. We spent many hours discussing the fine points of setting up the standard tremolo, and came up with the following modifications and adjustments that not only help the guitar stay in tune but improve its sound as well. And all this is possible without installing any of today's locking nut/bridge systems, all of which require alteration of vintage Strats. These tips will be a help to vintage Strat lovers who are trying to keep up with the modern music world.

SMOOTH TREMOLO ACTION AND BETTER SUSTAIN

Before setting the tremolo, adjust the six mounting screws that fasten the bridge plate—if they're screwed down too tightly, the tremolo won't have the proper freedom of movement. It's a good idea to loosen the screws slightly and then retighten them slowly until they just



touch the plate. Sometimes friction between the plate and screws causes jolting, catching, and sticking. One way to track down that problem (and often it's just one or two screws) is to remove the four center screws. Actually, the two outside screws alone are able to hold the bridge sufficiently for playing. Stevie Ray Vaughan sometimes used only two—proof of their strength, considering his high action, heavy strings, and hard-hitting blues attack. Test the tremolo function with only the outer two screws holding the bridge down, and then by replacing the screws one at a time, you'll find the problem. You can remedy this by carefully filing and fitting the holes to the screws:

With the bridge removed, inspect the six holes from the underside. You can increase the bevel by using a #4 counterbore (above). This increased bevel gives more of a knife-edge pivot point to the bridge where it rocks against the mounting screws, and therefore noticeably increases the sustain. Many bridges are beveled properly and need no modification, but it won't hurt to have a look. The bevels should be the same. Concentrate on the rear edge of the hole—the edge that bears against the screw. Bevel (countersink) the underside of the holes until the remaining rim is approximately 3/64" to 1/16" thick on each hole. When replacing the bridge, tighten all six screws snugly, and then back off each screw a quarter-turn; this keeps the bridge plate flat to the body while allowing enough room for the tremolo when in use.

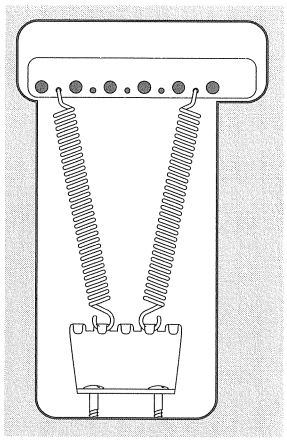
There are many ways to adjust tremolos other than the one explained here. The best way is to sit down and fiddle with your axe for a while to see what you like.

A different approach is to hold the tremolo forward in the tilted position, and then tighten the screws against the plate, preventing undue pressure on the screws when the tremolo is in use. Use whatever method suits you. I've known some players who prefer using two

mounting screws, yet would rather keep the middle four screws for looks. This can be accomplished by drilling clearance holes in the plate so that the screws aren't actually touching or holding anything. The instrument is altered, however, which could affect its value.

SPRING ADJUSTMENT

Adjustment of the standard two-piece tremolo involves much trial and error. In the end you must please yourself, and there is no one way to do it. Some players prefer that the bridge come to rest on the body as a positive stop or return point after being "dumped" (pressed downward to lower the strings' pitch). These hard-hitting, string-breaking players often like a positive body stop, so that the remaining strings don't all go instantly out of tune from the difference in string pressure caused by a broken string. The standard factory setup, however, is with the tremolo plate raised slightly off the body at its rear (3/32" as mentioned previously), enabling players to cause the pitch to go slightly sharp by pulling up on the arm.



The tension adjustment of the tremolo springs depends on string gauge and desired tremolo action—a personal choice. Many players want the plate to return to the guitar's face after use, but keep more tension on the springs than is necessary. Here's a good test for proper spring tension: Pluck the open low-*E* string and, at the 15th fret, immediately bend your top *E* string one-and-a-half to two steps. If the low-*E* holds true, the spring tension is probably correct. If it goes flat due to the additional pressure caused by bending the top string, tighten the spring claw until the low-*E* is close to remaining in tune. Experiment to find the springs that best suit your style. Not all springs are the same length, size, or material, so shop around. Players using sets beginning with an .008 to .009 high-*E* should experiment with two or three springs; .010s and up play best for me with four springs. Properly adjusted springs should ring clear when plucked, with no dull, plunking sound. A good spring tension and tone are important to a Strat's unique sound, since they create a natural reverb chamber.

No absolute rule exists regarding the number of springs used and onto what claw hook and into which tremolo block hole they should be placed. Some guitarists who favor light-gauge strings beginning with an .008 use only two springs with the claw backed most of the way out; .009 players often use three springs with the claw still backed out quite a bit. Most players, however, end up using either three or four springs and adjusting the spring claw to get the desired tremolo feel and return point. Some use five springs with medium or heavier strings (Stevie Ray, for instance, uses strings gauged .012, .015, .019, .028, .038, .058). I feel that five springs are too much, and I don't like the way a tremolo plays this way. String gauge is extremely important when adjusting tremolos, and you should decide on a favorite gauge before making any adjustments.

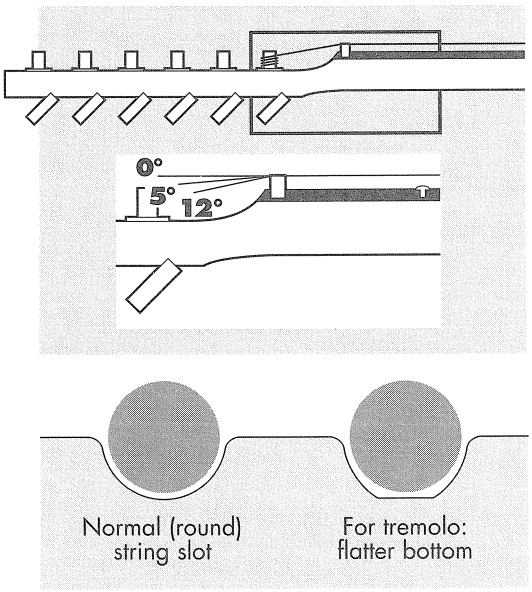
When experimenting with the number and placement of the tremolo springs, try two at first, placed on the second and fourth hooks of the claw and extending to the two outside holes of the block (left). If you want to add another spring—and most players do—place it in the center of the claw and block but relocate the other two springs to the outside hooks and holes. With four springs, simply omit the center one—the idea is to keep the springs balanced.

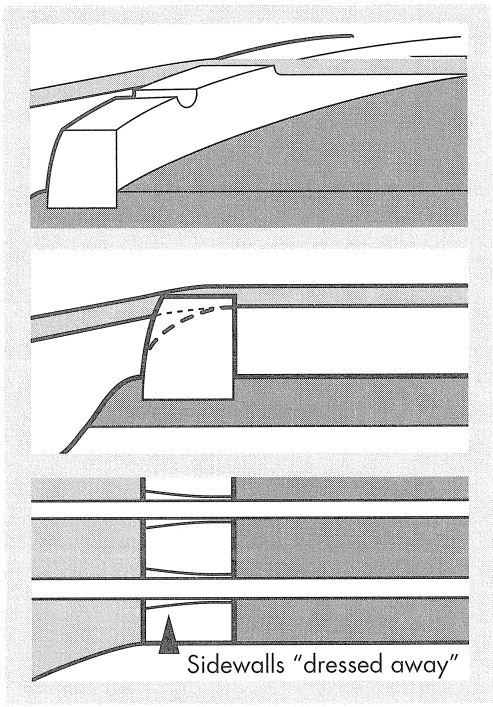
Here's a common tremolo setup trick that pleases most players: With the strings tuned to pitch, adjust the spring claw tension so that the bridge leans slightly forward, with the plate slightly off the face of the guitar (1/8" maximum). Fret an *A* at the 5th fret on the high-*E* string, and pull up on the tremolo arm until the plate hits the body and stops. Adjust the spring tension until the note played at the 5th fret is *Bb* when the plate hits the body. After this "half-step sharp" test is completed, you'll be able to pull up on the arm slightly. Of course, if you change string gauges or alter the number of springs, you have to start all over again.

ELIMINATING FRICTION

This information applies to any Fender instrument, but in particular to Strats with tremolos. If you eliminate the friction which causes strings to bind, you'll have a better playing axe—with or without a tremolo.

The modern locking nut/bridge system is so popular because it basically eliminates the





problem of slack storage—string tension that "hangs up" at the friction points outside the playing area in between the nut and bridge. When you tune a string or run it through the nut and string tree by depressing the tremolo, the friction points (nut, string trees, and less often the bridge) can make the string hang up, causing it to return sharp and throwing the guitar out of tune. The stored slack is held temporarily and usually releases the next time you make a bend or use your tremolo. If you retune this "sharp" string, it will be flat when it releases. Most slack storage occurs at the nut, at the string tree hold-downs behind the nut, and to a lesser degree at the bridge. If you eliminate these friction problems, your guitar will stay in tune. Start with the nut.

For nut-making, I prefer bone over man-made nut blanks of Formica, phenolic, or plastic. Graphite can be a good choice for tremolo nuts, but I don't like the black color and it seems to wear quickly. The string angle, which comes from the tuner or string tree and breaks over the nut, should not be too steep when viewed from the side. A proper angle is between 5 and 12 degrees off the fingerboard plane—no more, no less (above).

The nut's grooves or string slots should be deep enough to hold the string and keep it from popping out when played, but no more than half the diameter of the string in depth. A nut slot should have a round bottom, and the slot sides should bear slightly away from the string, so as not to bind. On tremolo guitars, some repairmen prefer a slightly flattened bottom for the string slot so that the slot's round shape doesn't grip the string as it moves (above, left).

Occasionally a repairman or manufacturer will hastily file nuts with too sharp a back angle. This puts all the load and friction at one very small point at the front of the nut. While the string should "take off" at the nut's front (where it meets the fingerboard and the actual string length begins), it should have some "meat" or backing behind it and gradually slope up to the front edge. The nut sidewalls should also be slightly dressed away from the string on the back side to allow free movement, and so that they don't pinch the string and keep it from returning to pitch (or cause a muting effect). Slots that are too shallow don't hold a string when it's bent from side to side, plus they can cause a string to pop out when least expected.

As a final step when you finish any nut—especially one designed for tremolo use—give a glossy polishing to the string-slot bottoms with (at least) 1000-grit wet-or-dry sandpaper; this relieves friction and improves tone. A little lubricant in the nut slot doesn't hurt either. Common nut lubricants are pencil lead, powdered graphite, Vaseline, or a Teflon lube such

If you remove your string trees, expect to make an adjustment in your playing style. The upper two strings will probably seem harder to bend.

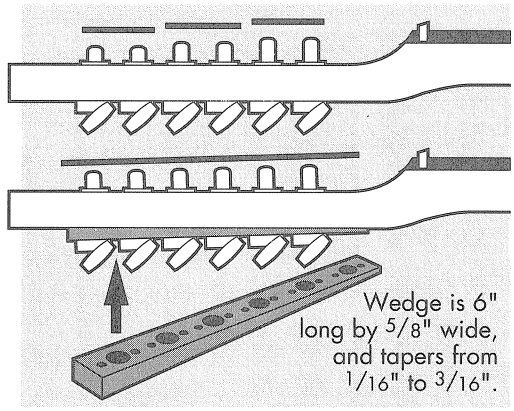
as Magik Guitar Lube. (The Teflon types are the least messy!) A well-fit and lubricated nut allows the string to travel lengthwise without binding. You may be wise to have a troublesome nut replaced by a repairman who understands tremolo problems and will shape one carefully from a hard material, such as bone. Or, be adventuresome and try it yourself after reading the "Nut Work" chapter.

STRING TREE PROBLEMS

Eliminating the slack storage occurring at string trees can be done in a variety of ways, but the removal of them alone is not a solution, because then there will be insufficient down-pressure, or angle, at the nut, and the strings may pop out when struck. Also, without a decent angle at the nut, a great loss of tone occurs. Roller trees are available from a variety of sources (check your music store—Wilkinson makes several). These are an easy retrofit for the originals, allowing the strings to move smoothly when the tremolo is used.

All Strats have a string tree for the *B* and high-*E* strings; on models made after '59, this tree is supported by a plastic or metal spacer. Often players remove the spacer and screw the tree down to the headstock face—don't do that! The angle becomes too steep, and the spacer is an improvement. Be sure that the string tree is deburred and polished, and use it. Strats made since '71 also have a tree for the *G* and *D* strings. The trees and spacers put enough angle on the nut to keep the string from popping out, but not so much that they cause the string to bind from friction and not return in tune. Combat friction at the trees with Teflon gun oil or Magik Guitar Lube—just a drop on the underside is a help.

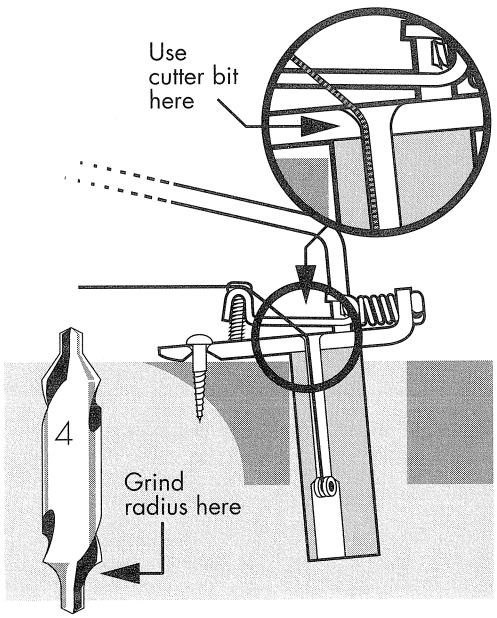
With the four highest strings, two or three windings around the tuner maintains a proper angle between the tuner and string tree. If you remove the tree that holds the *G* and *D* strings or own a pre-'59 one-tree Strat, experiment with the number of downward windings (toward the bottom of the tuner post) needed to achieve the correct string-to-nut angle. On the low-*E* and *A* strings, any more than two downward windings cause too great an angle, and the strings will bind when the tremolo's in use. A neat trick is to wind the string up toward the top of the post, to let you control or alter the angle.



You can eliminate the trees entirely by using replacement tuners with graduated shaft heights (above). Sperzel and Schecter offer graduated shaft pegs, so check with your dealer to find what's currently available. Installing these pegs, however, involves enlarging the tuner-shaft hole. Instead of enlarging the holes on his '62 Strat, Doug made a tapered hardwood wedge, drilled clearance holes for the tuners and screws, and slipped it between the tuners and the back of the headstock. This "wedge" solution works well, doesn't disfigure a vintage instrument, and is a simple way out if graduated shaft height solves your problem. Wilkinson also offers machined aluminum wedges just like Doug's, which work great. If you remove your string trees, expect to make an adjustment in your playing style, because the upper two strings may seem a little harder to bend; you may have to push further to get the desired note. You'll be pleased, though, that the string has a little more resiliency at the top of the bend. Also, this extra resiliency results in a lot less string breakage, since the strings tend to give more.

STRING BREAKAGE

Breakage usually occurs where the string angles over the bridge plate. You can radius (taper) these holes with a small file and sandpaper, or by grinding a radius on one end of the #4 counterbore mentioned earlier and using it in an electric drill to bevel the hole evenly (above, right). This type of counter-bore is generally used by machinists and is available at most industrial supply stores; any machine shop can quickly grind a radius on it. Besides



eliminating string breakage, this bridge-plate modification also helps eliminate binding that occurs at the same point. An easier solution is to do what Stevie Ray Vaughan did: Slide a piece of plastic wire insulation over the string at the point of contact at the bridge saddle. This must inhibit some tone and sustain, although you can't prove that by listening to Stevie Ray!

If you follow these tips, you should find that your guitar stays in tune nicely and has marked improvement in tone. For many years, the Strat tremolo has been a great invention; it simply needs a little understanding and care.

Tightening up a loose Strat tremolo arm

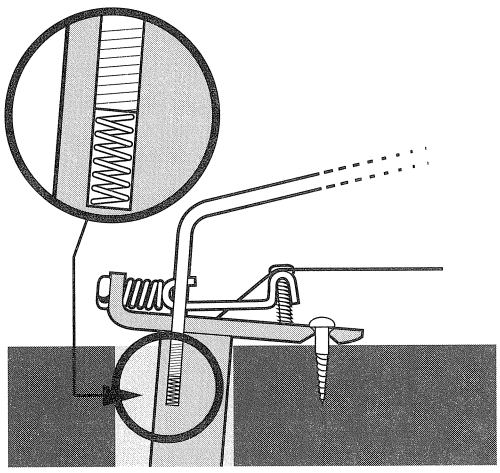
Here's an interesting idea from Roger L. Scruggs of Lynchburg, Virginia: "In regard to Strat tremolo arms going limp, I have a remedy that works well on my '63 Strat. I removed the center spring from a small die punch cutter and ground a ¼"-long piece off from one end. This spring is about 5/32" in diameter and very stiff. I then dropped the spring into the tremolo arm hole and screwed down the arm until it hit the spring (right). By tightening the arm slowly until it met with resistance from the spring, there was enough up-pressure on the bottom of the arm to keep it from rotating.

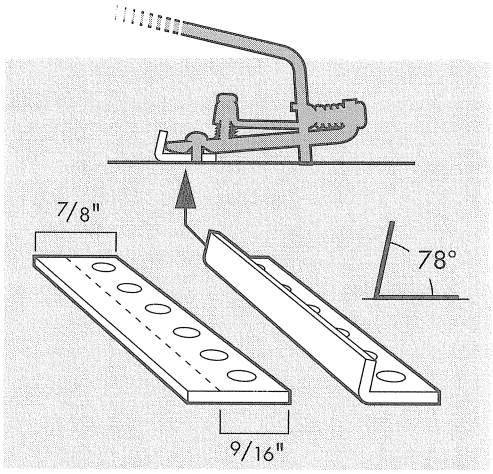
Being extremely stiff, this spring keeps the tremolo arm from being either too tight or too loose. I bought my punch/spring from Holiday Steel Rule And Die in Greensboro, North Carolina, but you should be able to find one at any die-maker's shop."

Roger's idea works great. Note that this will only work on old-style Strat tremolos (made before 1970) that have a bottom to the hole; otherwise the spring would simply fall out. Readers can avoid having to buy a die-punch cutter by finding a hardware or industrial supply store with a good selection of springs; any stiff spring works. Wear safety glasses when using a grinder, and be sure the wheel isn't cracked. Read the strict grinder safety precautions given in "Making your own fret files."

A Strat tremolo modification

Richard H. Ruth of Oklahoma City wrote to me: "I converted my tremolo from a face-mount to a semi-floating, knife-edge type. To do this, I bought some brass at a local hobby shop, bent it into shape, removed the tremolo, and mounted the new brass plate to the mounting holes on the body. Since the brass was bent to more than a 90-degree angle, it held the 'knife edge' of the tremolo when I replaced it. The only non-reversible alteration to my guitar came when I filed the underside of the bridge's leading edge to a sharper contact point. This modification changes the tremolo's pivot point





from the mounting screws to the front edge of the unit. The guitar returns to pitch almost as well as an expensive locking tremolo, and the tone is much improved. The only tools I used were a vise, a hammer, a ⅜" electric drill for drilling and countersinking the mounting holes, a hacksaw for cutting the brass to length, and a file. I replaced the original mounting screws with a countersunk variety having the same thread as the originals. The brass plate is 1/16" thick and around ⅞" to 1" wide, and I only needed to cut it to length. For a dollar I got enough brass to make two—and that was a good idea, since I messed up the first one (some experimentation was required to arrive at the proper bending angle so as to retain, but not restrain, tremolo movement)."

I asked Richard if I could borrow the guitar to try it out, and he sent it to me the next day. It works smoothly, and seems to return in tune well. Another nice thing about the conversion is that he enjoyed doing it. Many players love to customize their guitars and are looking for new jobs to do. Richard's idea is fairly easy to perform, and it doesn't really alter the guitar much. If you're squeamish about filing on your stock bridge, buy a replacement bridge/tremolo and use that instead—especially if you have a vintage guitar. A "floating" tremolo is one that doesn't come in contact with the body of the guitar when it returns to pitch, since it's raised up from the surface. This enables the player to pull up as well as push down on the tremolo arm. In some cases, the neck may have to be shimmed in its pocket to accommodate the shimmed-up tremolo unit. Thanks for the tip!

The Trem-Setter

Before concluding this chapter on tremolos, it's appropriate to say a few words about the Trem-Setter, a device that helps keep a tremolo guitar in tune. Designed by David Borisoff of the Hipshot Company, this tremolo stabilizer was first introduced in 1988. Since then thousands have been installed—not only by repair shops on a custom basis, but also at the Fender factory on their Strat Plus, Strat Plus Deluxe, and Ultra Strat guitars. Some players misunderstand the Trem-Setter's use and expect too much from it. So let's look first at what it will and won't do for a wang bar, and then I'll present some tips to make the installation even easier than it already is.

The Trem-Setter is an adjustable, spring-loaded device that replaces the center tremolo spring on locking or standard tremolos. It installs in the rear spring cavity, replacing the standard five-spring tremolo claw with two individual outer spring claws. This leaves the center spring area open for the Trem-Setter, which mounts on a hook (or "hinge-clip," as it's called) screwed to the cavity bottom. A brass pull-rod connects the Setter to the sustain block, so it moves with the block as the player works the tremolo and helps return the tremolo to the same spot after use. It also keeps even tension on the tremolo so that bending or tuning a string doesn't cause the other strings to drastically alter their pitch. The installation and adjustment instructions supplied by Hipshot and Fender are accurate, but a little too technical; they don't say enough about what the Trem-Setter does, or how it's done. So I talked with David Borisoff and Fender's George Blanda, both of whom had a lot to say.

"The main reason I designed the Trem-Setter," says Borisoff, "was to get away from the equilibrium, or balance, of the strings and springs controlling whether a guitar's in tune or not. The standard tremolo is like a bathroom scale—you can get on the scale twice and get two different readings. Or if you stand on the scale and shake, like shaking or bending a

string, you'll make the dial flutter on both sides of your actual weight. This is what happens to a tremolo bridge when you bend notes, play certain notes with a strong attack, or even hit certain open strings: You upset the balance, and the tremolo flutters back and forth. The Trem-Setter's like a car's shock absorber; it stabilizes the tremolo."

According to David, the unit accomplishes the following:

1 Improves the guitar's tone by controlling flutter. It stops the tremolo from absorbing or wasting the string's energy as it passes on to the body.

2 Helps the tremolo return to its zero point in tune. This is not true, however, if the guitar has a poorly made nut, inadequate tuners, or improperly mounted strings. Locking tuners and the Wilkinson roller nut work well with the Trem-Setter, of course.

3 Keeps the remaining strings in tune when you bend a string. String-bending adds tension and causes the tremolo to "sag," or lean forward, which lowers the pitch of all the other strings. The Trem-Setter keeps sagging to a minimum.

4 Makes string-bending easier. Since the bridge isn't sagging toward the fingering hand, lowering the pitch, you don't have to bend nearly so far to get a note. Players who don't like tremolo guitars may have a change of heart if they try one with a Trem-Setter.

5 Keeps the strings in better tune if you rest your hand on the bridge or intentionally mute the strings. It's not a big factor, but the Trem-Setter can be set up with this in mind.

6 Helps make up for worn knife edges at the pivot point.

Let me point out the one thing it won't do: It won't keep a guitar in tune if you break a string. It was never intended to. The amount of tension needed to compensate for a broken string would detract from the Trem-Setter's sensitivity.

I asked Blanda if all tremolos have bridge flutter: "At Fender we call it 'warbling' when you get the bridge flutter that David's talking about. Any well-balanced tremolo guitar warbles a little, but that's the trade-off for having a sensitive tremolo that's free from friction and returns to pitch. The tremolo moves to accommodate the different tensions it receives from the oscillation of the strings. This movement is less pronounced with a vintage Strat tremolo, since the bridge plate has a solid rest on the body; it's not delicately balanced on two knife edges like the American Standard. If you want to make a two-point tremolo warble, just to know what we're talking about, pick the *G* string hard at the 14th fret, or pluck it with your bare fingers, and listen—you'll hear it if it's there. At Fender it's easy for us to take two brand-new identical Strats, one with and one without a Trem-Setter, and compare their sound. You can really hear the difference. The guitar with the Trem-Setter has a better, more solid tone, and any warble is stopped." I've heard that Leo Fender called the tremolo's sustain block an "inertia block" in the original patent drawing, showing that he knew that something was needed to smooth out the string-to-bridge vibration and put the energy to good use.

Playing a guitar outfitted with a Trem-Setter feels more like playing a non-tremolo guitar.

The knife edges on a new tremolo are sharp, and returning to "0" is not a problem. As wear causes the edges to round off, it may no longer provide the frictionless movement needed to return to absolute "0." The Trem-Setter overcomes that friction.

How much does the Trem-Setter change the feel of a tremolo as it's being dumped or pulled up? Blanda responds: "Not too much, and not at all when you pull up, because the pull-rod moves through the spring on an up-pull, without affecting the tension at all. The tension of the Trem-Setter's spring is comparable to that of a normal tremolo spring. But rather than the spring stretching when you dump the tremolo, it compresses. A factory setup for a Strat Plus uses three springs and usually .009–.042 or .010–.046 strings. A player who wants to use only two springs and .008 strings couldn't benefit from the Trem-Setter, since it's a three-spring system. Besides, we don't recommend using two springs on a tremolo in the first place. I should point out that all springs are not the same tension; springs used on locking tremolo systems are typically stiffer by as much as 15%. In a repair shop, extra springs end up laying all over the place, and if the wrong springs end up being used along with the Trem-Setter, the tension won't be right when you dive-bomb."

Sometimes I feel, or almost hear, a little drag when I press the wang bar on a Strat Plus. "This

"I started out to make a completely 'stabilized' tremolo, but after finishing one prototype, I realized that I could get the same effect with the Trem-Setter and keep the cost down. Besides, most players would prefer not to replace their stock tremolo."
Dave Borisoff

is not normal," Borisoff explains, "but it can happen. Over time we discovered that if too much grease was used on the brass pull rod, it actually vacuumed around the small stop-collar washer as it moved, creating a suction effect. Dismantle the Setter, clean off any grease, and when you reassemble it, leave the washer dry or lightly lubricate it with WD-40. Be careful not to lose the washer when you take the device apart—the parts want to pop all over the place. We may switch to a fiber washer that not only won't vacuum onto the rod, but will also compress less, eliminating any possibility of slop. If you do take the unit apart, once the small slack spring that pushes against the stop collar is removed, you can see how the brass collar bears against the end of the threaded brass tube that the pull-rod slides through." How much can the nylon thread nuts be tightened or loosened when the tremolo's tension is being adjusted? "You can tighten it a lot," says Blanda, "but you won't want it too tight. You'd never want to see more than 5⁄16" of exposed thread on the brass tube: experiment till you find an adjustmnet that feels right. As for loosening it, by temporarily removing the lock collar spring as we mentioned, you'll see that loosening the nylon thumb-nut counter-clockwise too much causes it to hit the brass stop collar—you don't want that! The whole trick in setting up the Trem-Setter is to get the brass stop collar to make perfect contact with the washer at the end of the threaded brass tube when the tremolo is sitting at its balance point. Then any lowering of the tremolo arm puts the Trem-Setter into operation instantly. You can loosen the thumb-nut tension as far as you like as long as it doesn't touch the collar. Hold one nylon thumb-nut while you tighten or loosen the other; otherwise they'll just rotate together, and nothing happens."

I asked Borisoff if he thinks there's a tone improvement when a Trem-Setter is installed: "I don't think there's an improvement, I know it. When the string's energy hits the bridge, you want it to transfer instantly to the body so that the sound comes from the bridge and body together. When a tremolo flutters at the balance point, the tremolo block and springs cancel out and absorb much of the string energy that you're working hard to get to your amp. The player puts a lot in, but not enough comes out. It's like running in sand, where half the energy just pushes sand behind you, with only half left to push you forward. Get on solid ground, and you can take off with a one-to-one transmission of energy and no waste." Blanda adds, "There's a better coupling between the tremolo block and the body, which produces a difference you can really hear."

One of the big questions, of course, is how well does the Trem-Setter work with a standard Strat tremolo? "Quite well if the guitar is set up right," insists Borisoff. "A vintage Strat has friction at the six mounting screws of the bridge plate, as well as at the nut slots, non-locking tuners, and string trees. Comparatively speaking, a Strat Plus looks pretty good with its roller nut, two-point pivot, and lack of string trees and locking tuners. So setup is crucial on a vintage Strat. All friction points must be smoothed and lubricated so the strings can't hang up and store any slack."

INSTALLATION TIPS

Installation instructions come with the Trem-Setter, so rather than going through the whole operation, I'll just add my notes to what you already have. The installation only takes about a half-hour, and the tools needed are an electric hand drill, a small ruler, Phillips screwdrivers, and such. Adjust the stock tremolo to suit your tastes before you begin the installation, and take the time to set your guitar up right.

Since the original five-hook spring claw is replaced with two individual outer spring claws, you'll be setting the tremolo balance point with two springs instead of three; the Trem-Setter has no effect or spring tension on the tremolo until you depress or lower the strings. This enables you to tighten the spring claws closer to the end of the cavity than you could with three springs.

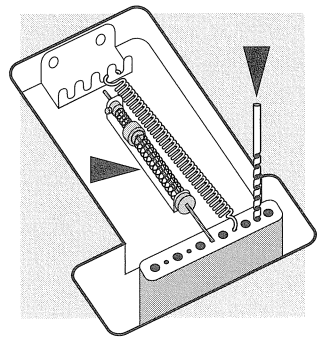
The hinge-clip has two mounting holes; the front hole (closest to the tremolo block) is located 3 3⁄8" out from the sustain block. The hinge-clip mounts at right angles to the block and in line with the center spring hole. Use a center-punch to mark the hole and help the drill bit stay on center. Use a #50 drill bit for soft

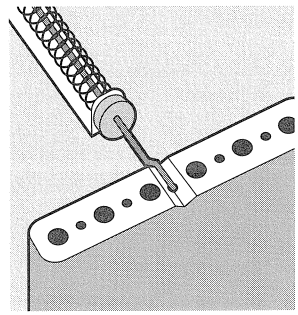
wood and up to a #80 bit for hardwood (the bits vary depending on the type of wood—practice drilling on scrap to be sure it works for you). Drill only the front hole at this time. Then temporarily mount the hinge-clip with one screw, and not too tightly. Now put the Trem-Setter onto the hinge-clip and snap the brass pull into the center spring hole of the tremolo block. Since the hinge-clip is slightly loose, it will line itself up naturally with the tremolo block. When it does, mark it, remove the Trem-Setter, and drill and mount the other hinge-clip screw.

The instructions call for drilling a 3/16" clearance hole in the end wall of the tremolo cavity, but they don't tell you that you really should use a long aircraft drill bit. You can order such a bit through a hardware store, or have the hole drilled at your local repair shop. The long bit can create the low angle necessary to allow proper clearance for the Trem-Setter's pull-rod. The bit I use is 12"–14" long. I use a smaller 1/8" bit as a pilot, and then enlarge that hole with the 3/16", so there's less chance for the larger bit to run off course.

I was thrown a couple of curves on two recent installations. The pull-rod hook and thumb-nut nearest to it scraped the back cover plate when the tremolo was dumped. The instructions advised rebending the pull-rod hook if this happens, so that its angle matches the angle of the hole in the tremolo block (it won't seat right if the angles don't match). I stuck a #50 (.070") drill bit into an empty hole so I could see the true angle of the tremolo block spring holes, and then bent the pull rod's brass hook to match (upper drawing at right). In one case this was the solution, but in another it wasn't—I found a different problem.

I was working with a replacement neck and body, an original Wilkinson roller nut (not the Strat Plus style), and a real American Standard tremolo that I got in a parts swap. By laying a straightedge across the back while working the tremolo, I could see just where it was rubbing, and that bending the hook wouldn't quite solve my problem. In this case the spring cavity was deeper than that of a real Strat (11/16" to 3/4" as opposed to 5/8"), causing the Trem-Setter's pull rod to rise at an angle where it hooked into the block. I used my Dremel tool with an abrasive mesh wheel to grind a groove across the bottom of the block (lower right), so the hook would sit deeper and at less of an angle. I might have been able to shim the hinge clip up 1/16" to 1/8" higher to get the same effect, but I took this route. You probably won't run into this problem, but if you do, you're ready.





One trick Dave Borisoff uses when the brass hook needs to be re-bent is to hammer on the hook with a center punch or nail set while it's in the trem-block; the block acts as an anvil, which shapes the hook to the right fit. I haven't tried this, but metal-working experience tells me it would work. The pull rod is made from a fairly soft brass, so don't hammer too hard—tap it!

In summary, I like the Trem-Setter. Here's what I think it can and can't do:

1 For me, its biggest feature is the way it eases bending strings and the fact that the other strings stay in tune when I get there.

2 It does a good job of helping a tremolo return to zero. It's perhaps 98% successful, so it isn't perfect: you should know that before you start. The slight 2% out-of-tune effect that may remain after dumping the tremolo can be straightened out by shaking the tremolo bar or hitting the bridge with the palm of your hand to settle it back into place.

3 As for the improvement in tone resulting from a better string/bridge/body coupling: if you can make an already great-sounding Strat Plus sound even better, I'm all for that.

4 String flutter or warble is something most players aren't bothered by, but for those who are we've now a way to eliminate it besides "blocking" the tremolo (many players shove a hardwood block between the sustain block and the body to improve tone, eliminate flutter, and stop the guitar from going out of tune).

5 The improved stability doesn't do much to keep the bridge from moving if you rest your hand on the bridge while you pick or mute the strings. It might do a little to help, but when you press down on the back of the bridge, you're pushing in the direction that the Trem-Setter's spring has no control over (this is the only claim of the manufacturer that I disagreed with). But David Borisoff explains that if you slightly

loosen the two tremolo springs and then tighten the Trem-Setter's buck spring a little, your bridge should have more stability in the string-raise mode, letting you rest your hand on the bridge more.

Alternatives to the locking nut

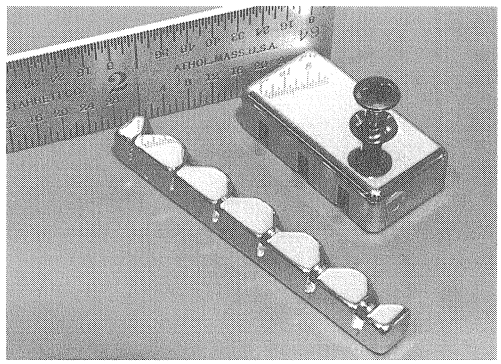
The Wilkinson Original Roller is an excellent tremolo nut that uses roller string trees, and it's offered in a variety of custom options. It's available through dealers and some guitar parts suppliers.

THE WILKINSON ROLLER NUT

Many tremolo users don't want to hassle with a locking nut and don't want to use a tremolo system which can only be tuned with fine tuners. To help guitars with traditional tremolos stay in tune (and help them return to pitch), Trev Wilkinson designed the "Wilkinson Roller Nut." It uses steel rollers in the string grooves, or nut "slots," to help ease the friction that occurs during tremolo use. Wilkinson's roller nut is significant because he also made a variation of it for Fender (the "Fender/Wilkinson Nut") which was Fender's non-locking alternative for tremolo players from 1987 until 1993—and standard equipment on many thousands of Strat Plus guitars during that period. Then, in the summer of '93, Fender switched to the LSR ball-bearing roller nut designed by Bill Turner. Here's some information on the Wilkinson Roller Nut.

Like Floyd-style locking nuts, the Wilkinson nut requires some removal of wood to create the flat on which it sits. Also, the end of the fretboard must be shortened by 1/16" in length so that the nut's rollers are in the correct spot for intonation. So, while the wood removal necessary for either Wilkinson nut is minimal when compared to a Floyd-style locking nut, some routing is necessary, and the need to shorten the fingerboard means you wouldn't be installing these on a vintage axe for sure.

The Original Wilkinson nut is 3/16" in width, which means you end up with a nut slot of 1/4" on a Fender or a Gibson. The nut comes with a separate "hold-down," installed behind the nut, to keep down-pressure on the rollers. (Fender's Strat Plus nut has six roller hold-downs built right into the nut frame, and that's



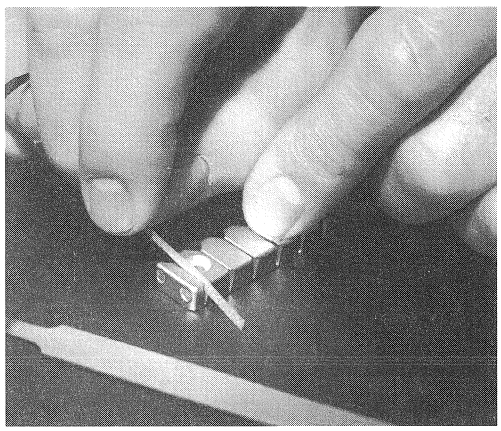
why it's significantly wider (1/2") than the 3/16" Original.

Both Original and Fender/Wilkinson nuts have a chrome-plated brass housing that holds six loose-fitting needle-bearing rollers at its front edge. The nut's six individual string slots measure, from treble to bass, .011", .014", .018", .028", .038", and .049". Deduct a half-thousandth (.0005) from each measurement for chrome plating, and you'll know what string gauges fit through the slots (a set of .010 – .046 works best, and an optional nut for .012– .052 strings was available).

The Wilkinson nut, at times, may exhibit any of the following problems: 1) seizing of the rollers; 2) too tight a string notch, which would bind on some strings and not allow it to return in tune; 3) sometimes, rattles or buzzing. Partly because of these intermittent problems, Fender retired the Wilkinson nut in the summer of 1993. According to Dan Smith, Fender's Vice President of Marketing:

"When we first looked at the Strat Plus, we knew we had a great unit in the American Standard Tremolo. We'd made 10 or 11 different tremolos over the past 15 years, and the American Standard was the best—it surprised even us. Taking advantage of this tremolo meant stabilizing what goes on at the headstock between the nut and the tuners. Trev Wilkinson happened along with his roller nut at just the right time. He redesigned it with exclusive, built-in hold-downs to do away with string trees on the headstock face.

"Our first model had rollers on the top three strings only. Soon, we installed them on all six strings to get better down-pressure on the wound *E*-, *A*-, and *D*-string rollers. This eliminated any chance of open-string buzz caused



by either inadequate string angle or from headstock deflection. It's a little-known fact that a headstock can deflect —or bend up—toward the strings. This changes the down-pressure slightly, but enough to cause a possible buzz. Some headstocks deflect, and some don't, even when made from the same tree. A traditional nut can work well with a tremolo, if everything's perfect and if it's made by a skilled luthier. But those 'perfect' nuts have only a short lifespan before wearing low enough to warrant replacement—another reason we wanted a roller nut on the Plus.

"We were happy with the Wilkinson nut, and of course there are thousands of Strat Plus Strats out there equipped with it—and an equal number of satisfied players. The fact is that less than 5% of those Strat Plus nuts had any problems. However, we never stop looking for ways to improve our products. We found that improvement in the LSR nut designed by Bill Turner."

SOLVING THE PROBLEMS

For those of you having problems with any version of a Wilkinson nut—the Original or the Fender version—here are some solutions:

First, eliminate any binding in the slot. A too-narrow string slot can cause a string to bind (usually the high-*E*), keeping it from returning to pitch or causing a buzz at the roller. The binding may be caused by a warp you could never see or measure, or it may be due to a bit too much plating. I use a "lightning strip" to carefully deburr the back edge of the string slot (above). These thin metal strips are coated with diamond dust; your dentist uses them to clean between your teeth after a filling—ask for one. I also use my .010" Precision Nut File, again on the rear wall of the nut housing. Don't scar the rollers!

Sometimes there's no binding trouble, but a slight buzz. Most likely, this sitar-like sound is on the high-*E*. If a buzz isn't being caused by string-slot binding, it's generally intermittent and will go away by itself (especially if you try to show it to your repairman). But if it won't play itself out, try these remedies:

- Simply put on a fresh set of strings.
- With the strings removed, tap lightly on the problem roller with a sharp-pointed tool such as an awl, ice pick, scribe, etc.
- Remove the strings and blow out the nut with compressed air.
- Loosen the nut's mounting screws, let the strings line the nut up naturally, and retighten. Often, just moving it like this solves the problem! Don't overtighten the two small mounting screws—just make them snug.
- Lubricate the offending roller after it's been blown out with air. To avoid attracting dust, use a non-oily Teflon type of lubricant. A little dab will do you.
- Rinse out a dirty nut with a spray-type tuner degreaser followed by a blast of air.
- To alter the nut height, your Fender dealer stocks stainless-steel nut shims in thicknesses of .002", .005", and .010".

REMOVING AND REPLACING THE WILKINSON NUT

Here's how Roger Sadowsky solves problems with the Wilkinson nut. Roger, of "Sadowsky Guitars" in New York City, is in the mainstream of guitar repair and setup. His repair work is renowned, and so are the guitars and basses he makes. Roger offers this solution to problems with the Wilkinson nut:

"I replace it when a customer experiences any problems. The nut really only works its best with .009 strings. As soon as you use .010's, the problem of the string binding in the slot often shows up. And the intermittant buzzes may happen with any string gauge (or not at all). We replace the roller nut with the Floyd-Rose Replacement Nut from Allparts. The Allparts nut is made from "Ebonal," a black, low-friction phenolic somewhat like Micarta, and was

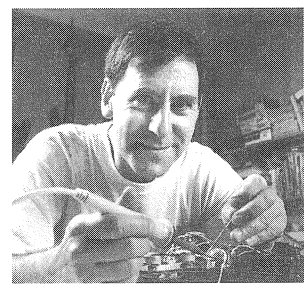


PHOTO © EBET ROBERTS

Roger Sadowsky

designed for players wishing to convert back from a locking-nut system.

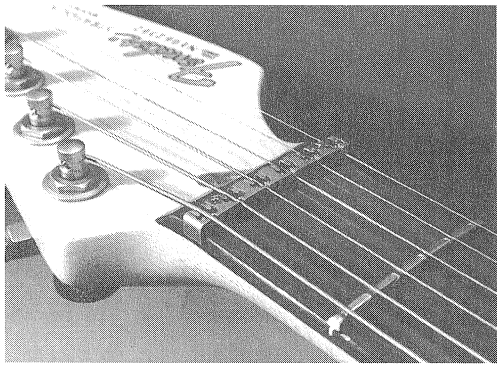
The truth is, I think most people are not knowledgeable enough about guitar set-up to complain. They don't know that it's not working right. I will say that if Trev Wilkinson himself installs the nut and sets it up, there won't be any problems. But most of us out in the field have met with some trouble. Here's how we take care of the problem:

1 Use a 1/16" spacer to add back the missing fingerboard length.

2 The Allparts nut has holes for the Floyd nut-mounting screws, but they don't match the Wilkinson holes. We avoid plugging and re-drilling mounting screw holes in the neck by simply super-gluing in the Allparts nut.

3 Mount a string retainer on the peghead behind the nut.

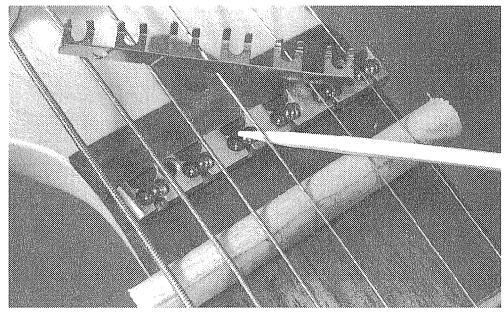
4 Adjust the string grooves in the replacement nut and set up the instrument."



FENDER'S NEW LSR ROLLER NUT

The LSR nut is now a factory installation on the Strat Plus, Deluxe Strat Plus, and Strat Ultra models. This innovative roller nut design features rotating steel ball bearings which are precision-set within a compact stainless steel housing, or "frame." (This frame is smaller than the Fender/Wilkinson nut—about the size of the 3/16" Original Wilkinson nut). There are two balls for each string, and the photos here show how it works:

1 The frame's string clearance slots will accept string gauges from .008" to .056" (high-*E* to low-*E* respectively) without touching the strings. The strings' only contact is with the the two steel balls. The steel balls accommodate—



and center automatically—the same variety of string gauges (.008" to .056").

2 Top view (with retainer clip removed, above) shows balls nestled in their respective housings. Notice the half-moon shaped neoprene pressure pads at the rear of the steel balls—these put just enough pressure on the balls as the strings move through them to eliminate ring, buzz, and rattle (but not enough to stop the motion). The top-mounted retainer clip holds the ball bearings and pressure pads in place, and screws down as the nut is tightened home.

Fender is also offering the LSR nut separately for custom installation (through your Fender dealer). This includes a special adapter for an easy upgrade of those models produced before the introduction of the LSR. If you have an older Strat Plus, Deluxe, or Ultra, you can switch to the new nut easily if you wish.

That's it for roller nuts. I'd say more about the LSR, but I haven't been able to find anything to fix on it. Being stainless it won't rust, and lubrication isn't even necessary, according to Dan Smith. An occasional cleaning with a dry toothbrush is the only maintenance chore!

String benders

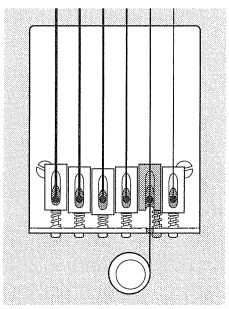
When Fender Telecasters are mentioned, talk of the late Clarence White and his legendary Stringbender is never far behind. In 1967 Gene Parsons created the first Stringbender for Clarence's Tele, and shortly thereafter Clarence immortalized it on the Byrds' *Sweetheart Of The Rodeo* album, with his buddy Gene on drums.

Beside the Stringbender, the other popular string-bending devices are the Glaser bender (used by Ricky Skaggs and Diamond Rio's Jimmy Olander) and the Hipshot (Hellecaster Will Ray's weapon of choice). All three devices create a "pedal steel" effect by raising a string's pitch (normally a whole step on the *B* string) when a lever is activated. Let's look at what's involved with installing these devices, starting with the original.

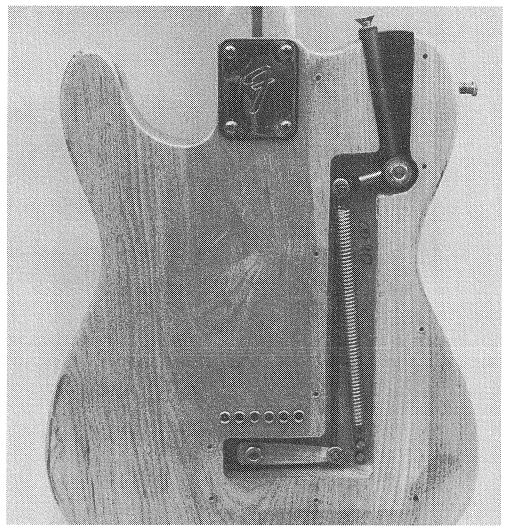
THE PARSONS/WHITE STRINGBENDER

Since it involves removing wood from the body, Stringbender installation permanently modifies a guitar. It's available as a $395 kit that includes an excellent 25-page instruction book, but the factory recommends having it installed by an authorized dealer/installation center ($550 installed). Do-it-yourselfers must have advanced woodworking skills, access to a router and drill press, and a good selection of hand tools. Here's why:

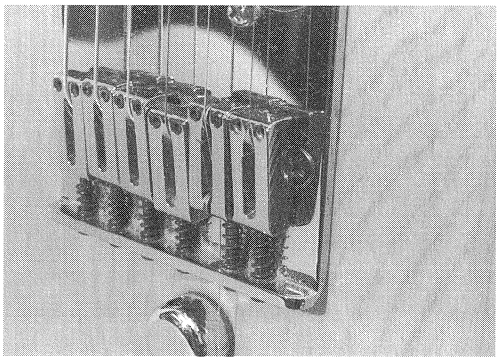
- A rear-routed cavity in the body houses the mechanism (above, right). The pull-lever connects to the guitar strap through the side (shoulder).
- Connected to the strap, the pull lever is activated by pushing down on the neck.
- The strap button on the pull lever travels $^{17}/_{32}$" when depressed, creating a whole-step *B*-string bend, and it moves a string-pull "hub" on the guitar's face..
- The *B* string runs from the pull-hub to the bridge saddle through a clearance slot cut into the bridge base plate. Traditional three- and six-saddle Fender bridges require only the slot. Imported bridges (such as Gotohs) with in-line, solid, flat saddles need additional machine work on the saddles. A new length-adjusting screw is moved over in the base of the saddle. The area vacated by the adjusting screw is ground away so that the *B* string is able to run onto the saddle.



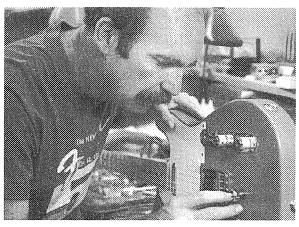
- Randy Stockwell, a great luthier in Columbus, Ohio, installed two custom-machined



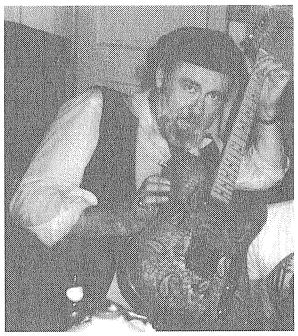
rollers in the saddle shown below: one puts down-pressure on the string, and the other is for the string to roll over. With the down-pressure roller, there's no need to machine a slot in the bridge plate, since the string can run straight through the original hole vacated by the length-adjusting screw. Randy no longer offers this service; he suggests you contact a local luthier with a good machinist's knowledge, and the proper tools, to make the alteration.



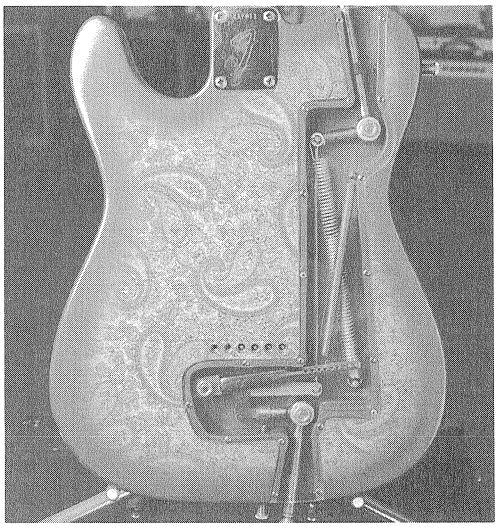
The Fender Custom Shop now offers a Clarence White Telecaster equipped with a Stringbender. Asked how a Tele's tone is affected by removing wood from the body, Custom Shop Stringbender expert Fred Stuart replied: "I've installed the Stringbender on two of my own Teles, but not vintage stuff, of course. It may sound strange—and some people don't believe it—but it improved the sound of both guitars. These were guitars I knew, and it just opened them up and made them sound more dynamic."

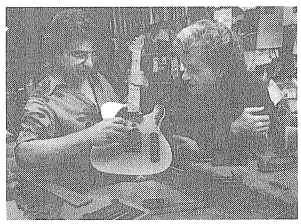


Fred Stuart



Roy Buchanan. At right: his rare "double-bender" with mechanism activated by both strap buttons.





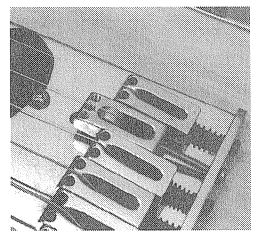
Joe Glaser and Jimmy Olander

THE GLASER BENDER

Joe Glaser of Nashville, Tennessee, made one of his earliest benders in 1979 for Jimmy Olander of the Diamond Rio band. Soon after, Ricky Skaggs made it famous on his Glaser-made "Mandocaster" and guitar. Joe's goal was to make a mechanism that could be installed without having too much of an impact on a guitar's looks or sound.

Joe doesn't offer a kit, preferring to install the bender himself, and he's only recently authorized installers in the field. The price, including installation, is $360. Three new holes have to be drilled into the guitar, removing roughly the same amount of wood required for a 9-volt battery installation.

- A ½" square hole under the neck plate houses the pull-lever mechanism. This lever extends through a small hole in the plate and attaches to the guitar strap with a StrapLok.
- A 1"x ¾" oblong hole is milled into the face of the body under the bridge for the string pull.
- A long (⅜") hole is drilled through the length of the body. This starts at the heel, runs through the body and oblong bridge hole, and out the guitar's butt end, where the tension adjustment is installed.
- Fine tuning is adjusted at neck's heel.



- The link stays invisible by connecting to the underside of the bridge where it comes through the bottom to the saddle's "pull finger", much like the pull-lever of a steel guitar.
- During a whole-step bend, the pull-lever's travel, or "throw," is about ½" at the strap button. This is the factory-preferred setting, although it can be adjusted much longer.
- Glaser prefers, and stocks, the Gotoh Tele bridge with six individual saddles, although his bender is compatible with a variety of bridges, including Fender's American Standard and the G&L Asat.

The Glaser bender, like the Parsons/White, is a permanent installation, since wood is removed. However, with the exception of the tension hole on the butt end, it can be removed with no visible effect. On a Glaser, the strap attaches at the neck plate, whereas the Parsons/White connects at the shoulder button in the normal position. "By attaching at the neck plate," Joe says, "the energy of the down-push is efficiently converted. You're not fighting the direction in which the guitar hangs, since the strap pulls in the direction of the lever rather than at a 45 degree angle to it." The *B* string anchors under the bridge on a hinged finger, transferring all the string pressure to the bridge plate while maintaining original string tension, saddle height, and sustain. The string doesn't slide back and forth over the saddle, thus eliminating friction and the possibility of squeaking. (With the Parsons/White and the Hipshot, the *B* string runs at a gradual angle to the saddle, which may weaken the tone of that particular string.)

Since 1983, Ricky Skaggs has used a Glaser bender on his "Mandocaster" 5-string electric mandolin. "I didn't start playing electric guitar in the band until '85," Ricky reports, "when Joe made me the first bender guitar, which I still

play. In all, I've got five guitars—a '57 Tele, the new Custom Shop Tele, two Glasers, and a G&L that Leo Fender gave me when he first started making them—and they all have Glaser benders. I set the bender for a whole step, and adjust the 'throw' to be a little on the stiff side—maybe stiffer than easy—because I don't want the weight to pull it down and out of tune when I'm standing still.

"Joe's a very creative guy with a real heart for music. He's such a great repairman, too. He does the work himself, and he takes care of all my stuff. Many people don't know the long hours he works to keep the Nashville musicians going. Joe teaches all the young musicians to appreciate a guitar that plays in tune and stays in tune."

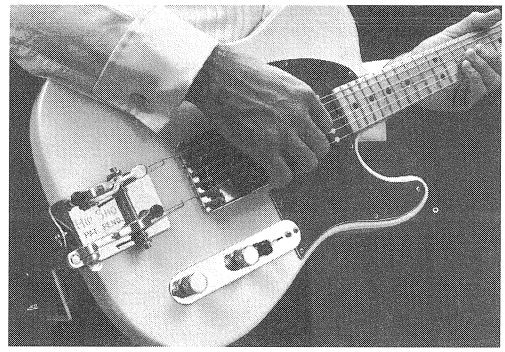
Glaser's double-bender is a second string pull (usually the *G* string) housed within the same space as a single bender. Also exiting through the neck plate, the *G*-bender connects to a small cord that attaches to the player's belt loop. Pushing away from ones' body activates the second pull. The cost of two benders is $700. Joe doesn't recommend starting out with two, since the second can easily be added later.

Jimmy Olander is the master of double-bending (just listen to "Meet In The Middle" on Diamond Rio). Jimmy reports, "I have one of Joe's first benders—a complete Glaser guitar, actually—built in 1979. I also have double-benders in a Strat, three Teles, and a bajo sexto from the Fender Custom Shop. I think differently when bending on a Strat—doing a more bluesy than country thing, and playing more single lines.

"With the double-bender, I set the *G* string, rather than the *B*, for the down throw [pushing on the neck], and I use it the most. The tension on my *G* string is set relatively stiff, and both of my pulls are set to a whole step. You can bend double stops in a whole step, or lower and raise the strings at the same time in whole steps. The double-bender was a trick to learn, but worth it! As for which brand of string bender to get, it's what you get used to. My Glaser is the first electric guitar I ever played. I came to Nashville as a banjo player ready to set 'em on fire, and nobody cared. So I picked up a guitar to make a living, and I'm glad I did!"

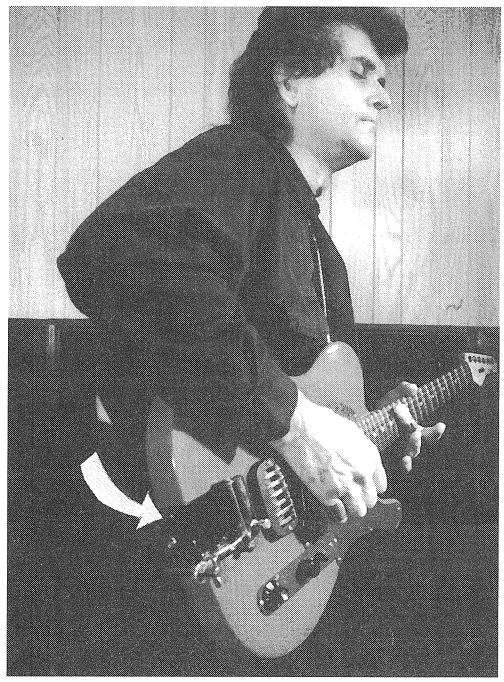
THE HIPSHOT BENDER

You can install the Hipshot bender yourself in minutes, and it's not "permanent," since no mounting holes are drilled. Designed by David Borisoff, maker of the Tremsetter and the Trilogy Multiple Tuning Bridge, the Hipshot adapts to a Tele, Strat, 335, Les Paul, and many other models. The weapon of choice for Will Ray of the Hellecasters, the Hipshot is easy to install:



■ Temporarily remove the strap button on the butt end. Locate the clearance hole in the Hipshot's trapeze tailpiece over the strap button hole, and remount the strap button, which holds the Hipshot in place (above). It's that simple! A movement of the hip and/or a slight pull on the guitar activates the lever.

■ For additional strength, Will Ray drills two extra mounting holes through the tailpiece and into the guitar's butt end (below). This isn't necessary, but it does make the unit more stable.



It's a good idea if you're not dealing with a vintage piece. (In the photo Will is using a "ring slide" for slide guitar effects.)

- The hip lever can be located anywhere along the tailpiece bar by loosening two snap rings and sliding it over—a nice feature.

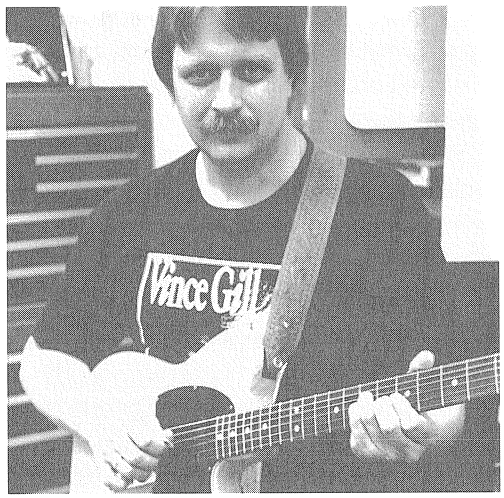
- The standard Hipshot comes with a "toggle tuner" that drops the low *E* to *D*. It can be moved to other strings, or more can be added (with toggles on the low *E*, *A*, and high-*E* strings, for instance, you could instantly drop into *G*-tuning).

- A palm lever may be added as an option. The Max Hipshot setup is three toggles, the hip lever, and a palm lever (all strings are loaded except for the *D*).

Will Ray points out: "With the Hipshot, you can have benders on several guitars for the cost of one Parsons/White or two Glasers, or move a bender from one guitar to another. After using it for 10 years, I can install one in about 60 seconds; then I'll spend half an hour getting the lever in exactly the right spot. For smooth operation, lubricate the friction points —the nut, string trees, and *B*-string saddle—with Teflon gel. If you have roller string trees—my G&L has them for the *E*, *B*, *G*, and *D*—you don't need the gel.

"I activate the lever by rocking the guitar, not by pushing my hip into it. I push the guitar with my right hand until the hip lever moves. The Hipshot's sensitive—I set it for whole step bends—but I can bend half steps too, by stopping halfway. It took a lot of practice, but that's the challenge of it."

My string-bending consultant for this section was Mike McGannon, guitarist with the Men Of Leisure band in Columbus, Ohio. A string bender since '78 and an authority on the subject, Mike offers this advice: "Installing a permanent string bender is an expensive proposition that can't be undone. Who you deal with to install it and the kind of service received from those people who take your guitar and 'make it more' is very important. Your guitar will come back as something different, so you must have a positive feel for both the installer and the manufacturer."



Mike McGannon

Mike recommends these albums for aspiring string-benders: Albert Lee on "Blue Memories," from Patty Loveless' *On Down the Line*, and "Settin' Me Up" on *Hiding*; Mike Warford on Linda Ronstadt's "Willin," from *Heart Like A Wheel*; Marty Stuart's "I'm Blue, I'm Lonesome," from *Tempted*; Ricky Skaggs with Mark O'Connor on "Restless,"from *Nashville Cats*; *The Return Of The Hellecasters* with Will Ray, John Jorgenson, and Jerry Donahue; Jimmy Olander's "Meet In The Middle" and "Pick Me Up" on *Diamond Rio*; and Clarence White's classic "Muleskinner Blues" from *Muleskinner*; and "Truck Stop Girl" on the Byrds' *Untitled*.

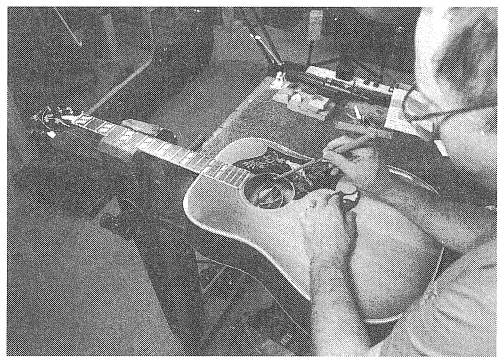
The setup of flat-top acoustic guitars often borders on repair work. It's not like electric guitars with their mechanical, easily-adjusted bridges.

Troubleshooting bridge problems before setup

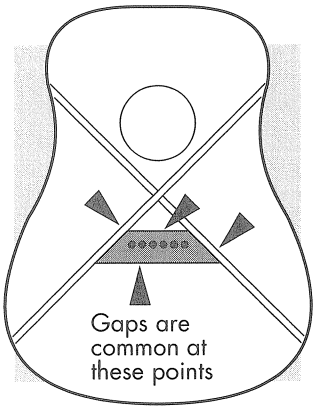
Certain things must be understood about an acoustic guitar before you can even *think* of setups. And some adjustments—often those made to a bridge—fall into the "repair work" category. We'll look at some of those problems here, and then deal with their solutions in the Acoustic Repairs chapter.

FLAT-TOP BRIDGE (AND BRACING) PROBLEMS

No part of the acoustic guitar is more important than the bridge, which transmits sound from the vibrating strings to the guitar's soundboard. And if the bridge has problems, the guitar's tone and volume have problems. Therefore, players of acoustic guitars should become acquainted with the telltale signs of bridge trouble and learn what constitutes proper setup. There are many problems common to the glued-on, flat-top guitar bridge, such as splits, warps, and saddle faults. This bridge overview should help you in evaluating your own instrument, whether you do the work yourself or have it done by a specialist.



Bridges separate from the top for many reasons, not all of which can be detected from the outside. Because of this, I always look inside a customer's guitar before quoting a bridge repair job of any sort. Buy an extension-shaft inspection mirror at a hardware or auto parts store. Then, with the guitar tuned to pitch, use a desk lamp for light and inspect the guitar's insides, paying special attention to the bridge plate (photo above) and the main

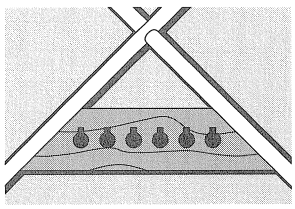


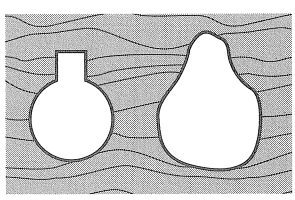
braces. If any braces are loose, you'll see a gap between the brace and the top. Learn to use the lamp and mirror together, reflecting the light source against the top while you look.

On inexpensive guitars and many imports, the two main X-braces often come unglued in the bridge area. This allows the guitar top to bow or hump, and causes the flat-bottomed bridge to pull away from the top's curve. Before regluing the bridge, the braces must be reglued. Sometimes the bridge plates have obvious gaps, or they're made of thin, warpy plywood instead of a proper hardwood. A combination of gluing the braces and replacing the plate can flatten a humped top (see Acoustic Repairs chapter).

In checking for a partially loose bridge, use the flap of any string package as a feeler gauge. Try to slide the paper between the guitar's top and the back of the bridge while the instrument is tuned to pitch. If you can get a ½" length or more of paper under it, the bridge should be removed and reglued. If there is only a hairline gap, often glue can be worked into it while the string pressure helps keep the loose joint open. The strings are then quickly removed, proper clamps and cauls are applied, and the joint is left to dry overnight.

When a bridge has come off entirely, you must choose between regluing the same bridge or using a replacement. I often replace a bridge if one or more of these problems are involved: serious splits in the bridge, a warp in the guitar top or bridge (making a proper refitting impossible), poor intonation, or a cheap original bridge with a saddle that raises or lowers by means of adjustable thumbscrews (I like to replace these with a standard bone saddle). Consider all the facts—and don't be hasty in slapping a bridge back on.





Fitting flat-top bridge pins

Those are some of the common problems that can befall an acoustic guitar bridge, including top and bridge warpage, loose braces and bridge plates, splits, and other serious ills that may require total bridge replacement or serious repair. Of course, any such work must be completed before you can set up an instrument. Now let's look closer at setup particulars such as shaping the bridge-pin holes and string notches, as well as the various aspects of saddles, including size, shape, and slots.

Flat-top acoustic guitars only sound their best when the strings are correctly installed and well seated in the bridge-pin holes. The bridge has two functions: to hold the strings and to transmit their sound to the body. Any problem in either of these functions results in loss of both volume and sweetness of tone. Every detail counts. For example, on a well-made bridge, the bridge-pin holes should be reamed carefully so that the pin is snug, but not too tight. A string's ball end must fit firmly against the bridge plate on the top's underside. It should never be pulled up into the bridge plate, the top, or the bridge itself. Bridge pins that pop out or "creep" up, string-end windings that pull up onto the saddle, or a dull, muted tone are indicators that things aren't right down below. Also, I prefer to see a slight chamfer (countersink) on the bridge top so that the head of the pin has clearance around it. This chamfer not only looks attractive and allows the pin to sit lower in the bridge, but it also lets you get under the pin's head to pry it out when changing strings.

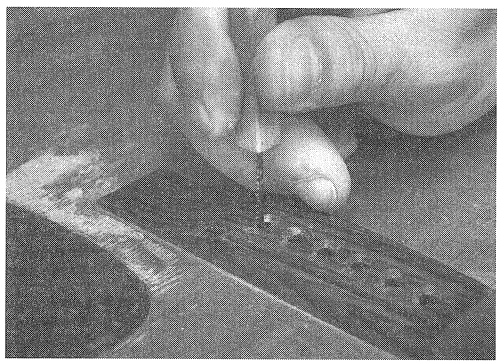
Use a telescoping inspection mirror to look at the guitar's interior, especially the top, where much of the string pressure is transmitted. Check to see whether the string ball ends are pulled neatly against the hardwood bridge plate as they should be, or instead are working their way up into the plate, top, and eventually the bridge itself.

Most bridge-pin holes have a slight notch at the front edge for the string winding to pull into (the drawing at left compares a cleanly cut hole with a worn one). The pin's job is to keep the ball end shoved forward into this notch when the string is tuned to pitch. Each string, being a different diameter, requires a properly sized notch in the bridge. Theoretically, a properly fit string, notch, and bridge pin would

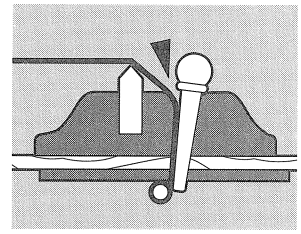
often allow the complete removal of the pin with the instrument at pitch—leaving only the notch to hold the string—but there's no need to try it!

String notches were originally used because the bridge pins of the '30s and '40s were solid—without grooves, or "flutes" (a flute is the groove molded into the pin, which accommodates that portion of the string winding that isn't seated into the notch). With an unnotched bridge, the string and the bridge pin would pop out. In the '50s, when bridge pins became grooved, a smaller string notch was required. I think a slight notch and the old-style solid bridge pins produce the best sound.

Most modern bridge pins are installed with their flutes facing forward, but bridge pins don't ha*ve* to be installed with the flutes forward: With older guitars and instruments with worn, overly deep notches, turning a bridge pin 180°—until the groove faces the rear—helps hold a string in a notch, especially a wound string. This simple pin rotation often keeps a slightly loose bridge pin from falling out all the time, too.

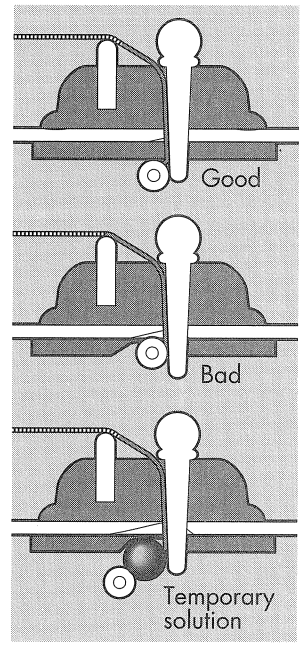


Many bridges (generally on inexpensive guitars) have only very slight notches, or none at all. It's best to create or enlarge these notches until the string locks in. I use a miniature, wooden-handled jigsaw blade for slotting bridge-pin holes. I customized the saw by removing the blade, flipping it end-for-end, and then regluing it into the handle. Now the teeth of this "bridge-pin hole saw" point upward (toward the handle), and cut on the upstroke—avoiding the tendency to tear out bridge-plate wood, which can happen on a saw's down, or "exit," stroke. After sawing, use a small needle file to smooth and radius the slot's top. The notch should be radiused toward the saddle where the string breaks as it comes out of the hole (arrow at right).



Slotting bridge pin holes is a simple and inexpensive job, but it requires finesse and experience, so consider having it done in a professional shop.

After a bridge is glued onto a guitar, the bridge-pin holes are drilled through the top. A hardwood block should be held on the inside to absorb the shock and keep the drill bit from breaking out wood from the bridge plate as it plunges through. This step is often omitted, especially on cheap guitars or in work done by inexperienced craftsmen. Again, the mirror can tell you a lot in a hurry. If the bridge and plate holes are fractured, punched out, or simply worn out, the string windings will most likely end up on the saddle, and the ball end will pull into the bridge plate, but don't despair—the problem is fixable (see the Acoustic Repairs chapter).



Or, here's a *temporary* solution for badly worn holes. It works well and may even add tone and sustain to lower-quality instruments: slide a plastic, wood, or ceramic "spacer" (a bracelet or necklace bead) over a string's windings and up against the ball end. Now the bridge pin can properly hold the string and spacer against the bridge plate, as in the bottom drawing at right. I took apart a fishing lure—a Mepps Spinner—and used the cone-shaped brass weight as a spacer. It cost me six lures for my set, but they have a great tone, and I use them in my shop during this type of repair. Obviously, after adding a spacer to the ball end, you'll have to string the guitar from the inside, since the beads won't fit through the hole!

Getting a string end to "lock in" at the bridge notch is simple, but requires skill, experience, and the proper tools. Also, this notching of the bridge may require some refitting of the bridge pins to their tapered holes. It's easy to end up with loose bridge pins that fall out after these adjustments. So if all else fails, don't hesitate to take your axe to a pro!

Refitting and replacing bridge saddles

Practice saddle-making on scraps of wood or inexpensive Micarta and Corian saddle blanks. Save the bone for when you're an expert!

Acoustic players who search for the utmost in tone and volume can't be particular enough about having a well-fit saddle. Made and installed properly, the saddle puts the finishing touch on expensive, high-quality instruments. The same attention to detail in fitting a saddle to a less-expensive model is probably even more important—it's amazing what a tone depressor a poorly installed plastic saddle can be. Here I'll describe symptoms of "saddle sores," and suggest methods for cleaning the bridge slot and fitting a new saddle into it.

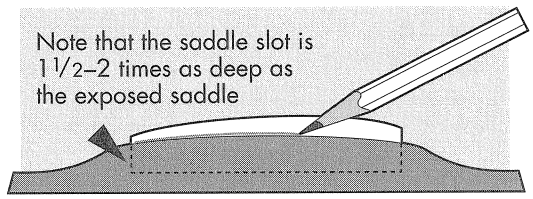
Since the saddle is the final stopping point of a string's length, its placement is essential in determining proper intonation. More important, it's the transmitter of sound from the vibrating string to (and through) the bridge, causing the top to move. This creates the sound, tone, and volume that is unique to each individual guitar. In order of preference, my choices of saddle and nut material are: ivory or bone, Micarta, and plastic. Bone is the best all-around material for saddle-making, since it's readily available, inexpensive, and quite hard.

A saddle should be replaced when:

- It fits loosely in the saddle slot and can be easily moved with the strings removed. This loose fit may not only cause vibrations and slight buzzes, but it also seriously inhibits the guitar's ability to produce volume—not to mention tone.
- It has become pitted or grooved from years of use. To file or sand out these imperfections would lower the action—time for a new saddle.
- It is made from plastic, and the player is looking for more volume and better tone. In my opinion, plastic just won't cut it.
- The slot is too shallow, causing the saddle to lean forward and eventually develop a warp or crack. In this case the slot should be recut deeper before fitting another saddle (more on this later).

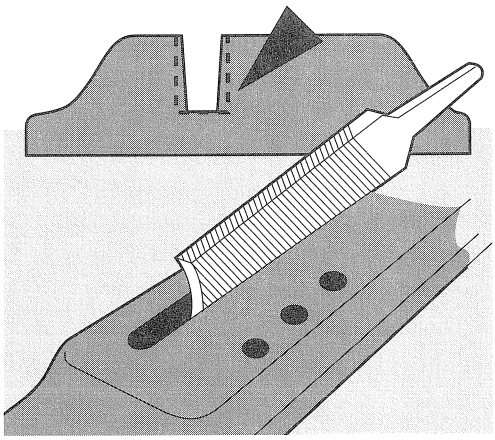
Sight across the bridge from the side, looking lengthwise along the saddle. If it looks curved or warped or seems to tilt forward, most likely the saddle should be replaced (and the slot it rests in should be trued, or "squared-up" too). This "squaring the slot" is important, since there is a huge difference in power and tone transmission when the saddle fits well. A saddle should be somewhat difficult to remove, due to its tight fit. In fact, you should be able to grasp a well-fit saddle with a pair of pliers and pick up the whole guitar with it (but don't try it!). However, a saddle that's too tight or forced into its slot could cause the bridge to split.

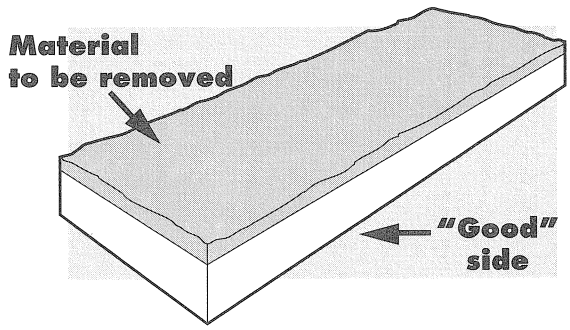
If you feel like attempting your own saddle work, don't start on a guitar that's dear to you; search out a clunker for practice—they're easy to find. Regardless of whether you work on your best guitar or a yardsale special, record the saddle's height before removing it. Make a mark on the front and back of the saddle with a sharp pencil at the point where it enters the



bridge. This will help you remember the saddle height after you have installed the new saddle blank and are ready to set the string height. Remove the saddle by gripping it with a pair of end-nippers or pliers, and gently rock it side to side slightly as you pull upward. Don't force anything, and remember that some saddles are glued in. If you have too much trouble, take the guitar to your local repairman. When the saddle is out, mark the bottom on the treble side with a small "X." This will help you remember which side was treble or bass when you're ready to trace it onto a new blank.

Before you can replace the saddle, you must be sure that its slot is well shaped and straight from end to end, with smooth, perpendicular sides that are square to the bottom. The slot should be deep enough to support the saddle well (approximately one-and-a-half to two times the saddle's exposed height above the



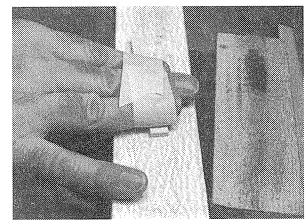


bridge top). It's not uncommon to find sides that are shaped as those at right, with lines that are not perpendicular to the bottom or parallel to each other. Going slowly from end to end with a sharp, long-beveled chisel, you can pare the wood from the sides to square up the slot. A spark-plug file with the tip ground as shown can be used as a scraper on the push stroke, filing at the same time. It's also great for smoothing and straightening a slot from end to end, as well as for cleaning up any chisel marks. If the slot looks good to begin with, try inserting a standard blank into it and don't mess with trying to change its size—I haven't run into this situation enough times, however!

If the slot is too shallow, allowing the saddle to lean or fall over, it must be made deeper. The best method is to rout it with a Dremel Moto-Tool mounted in its router base. Actually a miniature router, this tool is well known by professional repairmen and serious hobbyists. The base can hold the router at right angles to the bridge, and with successive passes of 1/16" or so, you can quickly reach the desired depth. After routing, clean up any slight marks on the sidewalls with the chisel and file. Wear a dust mask while cutting or sanding bone or hardwoods.

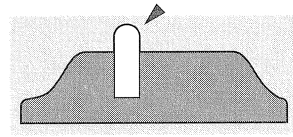
Most saddle blanks range from 3/32" to 1/8" in thickness. While some replacement saddles drop right into the existing slot, most are thicker than the original by as much as 1/32", to account for the squaring-up and consequent over-sizing of the old slot.

I prefer the oversize blanks of bone, and usually size them on a stationary belt sander. Slower but no less accurate results can be achieved by hand. First smooth and flatten one side by rubbing the saddle against a mill file (the same file used for leveling frets; see the section on making your own files). After measuring the saddle-slot thickness, transfer the measurement to the new blank with a pencil or scribe, measuring and marking off the good, flat side. Remove material from the opposite side until you come to the measured line. This can be done by rubbing on the smooth file or against 180- or 220-grit sandpaper, or by using a scraper blade. C.F Martin repairman Rich Starkey wraps tape around his fingers to hold a saddle which only needs light thicknessing to get the proper fit. When the blank begins to fit, trim it to exact length and round the ends to match the slot's dimensions.



Rather than just dropping in, a well-fit saddle "squeaks" when installed. Support the guitar under the bridge with your free hand while pushing the saddle in from above. A too-tight saddle might eventually cause the bridge to crack, or it may not go in at all. Once in-serted, it's hard to remove for shaping and action work, so practice on inexpensive in-struments if you want to do your own work.

When the new blank fits into the slot, recreate the former string height and saddle shape by referring to the original, which you've marked with a pencil. If you didn't like the feel of the original action, reshape the new saddle to suit your taste, raising or lowering the strings by degree. In general, the saddle should follow the fingerboard's curve somewhat, but rise slightly and flatten out a little as it goes toward the bass side. In other words, the bass strings should be higher than the treble strings to avoid buzzing. While roughing in the saddle, always be sure that its top, or crown, is rounded, so you won't be breaking strings each time you string it up to check the action.



The correct shape for the saddle top is smoothly rounded and free of sharp edges. The saddle should be showing 1/8" to 3/16" exposure above the bridge. This ensures a string angle steep enough to produce good volume. An over-height saddle exerts too much pressure on the slot, and can cause the saddle to warp. A height much less than 1/8" does not give the guitar's body enough chance to sound.

When you reach the desired action height, final-shape and round the saddle to a gentle curve and polish it with 400 or 600 paper. This final setting of the action is actually extremely tricky and requires much practice.

Evaluating Acoustic Action

Here's a letter from a worried acoustic guitar owner, and his concerns are no doubt shared by many players. It's a good example of some of the problems discussed in this chapter:

Dear Dan:

I've been advised to get some work done on my steel-string, and I'd like a second opinion. The guitar is a good-quality ($900) import with a solid-spruce top and laminated back and sides; I bought it in 1988. The problems are that the action has gotten high and the strings buzz at the lower frets (up to the 5th). I took it to several repair shops without too much satisfaction.

Here's what happened: Adjusting the neck didn't solve the buzzing problem, so the frets were filed, but it still buzzes. A neck adjustment helped significantly with the high action problem, but it was still stiff. The saddle was then filed lower to further bring down the string height, but the strings rattled slightly at the saddle since the angle had been lowered so radically. Then the repairman cut slots in the bridge behind the saddle to steepen and improve the angle as each string came out of its hole in the bridge. I have been told that this is normal and that nothing is wrong with my guitar, but in the future I may need to have the bridge shaved thinner to further lower the action. Now I have a guitar that has good action, but it still buzzes and has an ugly bridge. Are these techniques standard practice, or is all this work a compensation for poor construction? Why is the guitar still buzzing? And what about this bridge shaving?

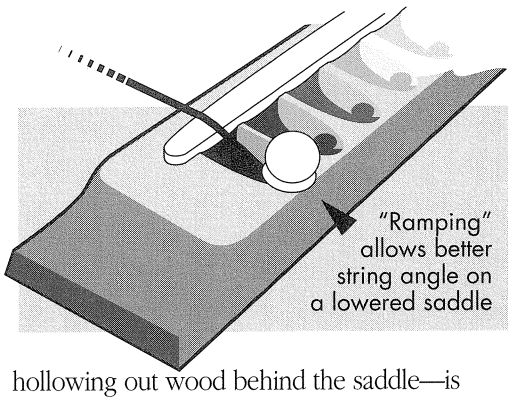
P.S. I live in the Southwest, where the climate is very stable and supposedly good for guitars.

All guitars, especially new ones, need adjustments over the years to compensate for any or all of the following: climate; settling of the entire instrument; poor construction; a basically good construction, but with poor design in one area (perhaps the neck-set in your case); average wear and tear. Your problems are common, so let's analyze the repair work that has already been done to your axe.

- Adjusting the neck can eliminate buzz if the frets are levelled correctly to begin with. Straightening an up-bowed neck (excessive relief) will significantly lower high action. But even a neck with perfect frets can be adjusted either too straight or with too much relief, and you'll end up with buzzes if you haven't matched the adjustment to your playing style and string gauge.

- Leveling the frets can help eliminate buzz, but if the frets only buzz up to the 5th fret, perhaps they have been worn much lower than the rest of the fingerboard (this is common if you play mostly in the first position). Instead of lowering the remaining 16 frets to the height of the first five, you might have to replace the five frets (a "partial refret") to bring them up to the height of the others. If you're still getting buzz, it could be coming from the bridge saddle. Also, remember that some amount of buzzing is normal for a steel string resting against a metal fret. Don't be too finicky!

- Cutting slots from the bridge pin holes to the saddle is one way of getting sound out of a low bridge saddle, since it improves the string's break-angle over the saddle. This is not a preferred method, however, and usually the saddle is only low because it's been sanded to improve an action that's too stiff, as in your case. The slotting technique you refer to—

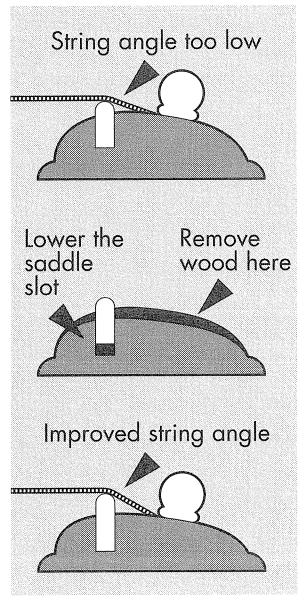


hollowing out wood behind the saddle—is often referred to as "ramping." Ovation uses this ramping technique in the manufacturing process. I don't think it looks good on guitars that weren't designed with it, but on Ovations it looks cool because the guitars are so modern in design. Cutting these slots is acceptable as an inexpensive fix-me-up, but not the preferred correction for a good instrument.

■ If the bridge is 11/32" thick or more, it is okay to shave it to expose an almost-buried saddle (see drawings at upper right). The process involves removing wood from the top and re-cutting the depth of the slot that holds the saddle (since it would be too shallow once the wood is removed from the bridge). For the record, the most commonly accepted steel-string bridge thicknesses are 3/8", 11/32", and 5/16", although you'll often see bridges shaved to 1/4", which makes me nervous. To many of us, even 5/16" is beginning to get a little skimpy.

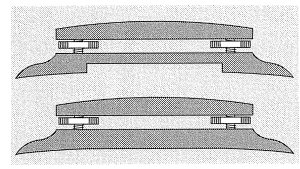
■ In your case, a neck reset may be the best way to lower the action without totally losing saddle height (as well as the guitar's volume and tone). Neck resets are more complicated and expensive than grinding down the bridge/saddle or slotting the bridge behind the saddle. Most imported neck joints I've seen don't reset as easily as Martin, Gibson, Guild, and many other American-made guitars using the traditional dovetail joint and conventional glues.

But now for the crux of the matter. Your repairmen should have advised you to take the guitar back where you bought it so that the dealer could send it back to the distributor. Since many repair shops have little or no experience in retailing, they often don't realize how well most manufacturers back up their products. Often distributors of the more recognized imported brands such as Takamine, Alvarez, Washburn, etc., will even replace the whole guitar to keep a customer happy, especially with a higher quality instrument. Of course, it's only fair that you must be the original owner. It may not be too late to send it back to the maker, so at least give it a try. Good luck!



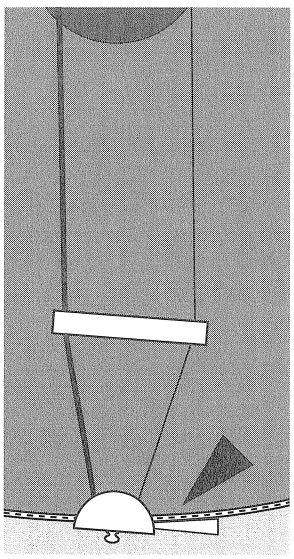
Arch-top bridges

Arch-top bridges often suffer from a poor fit of the bridge base to the guitar's top. The best fit can be achieved by hand, using a sharp knife such as an X-acto or a violin-maker's knife. It takes a great deal of skill to do this, however. As a substitute you can tape a piece of 120-grit sandpaper to the top and then slide the bridge base back and forth to contour it. The shape that a knife gives produces the cleanest fit and best tone. Good violin makers are the most adept at this bridge-carving technique. If you can find a person good at violin setups, see if they'll carve a bridge to fit the top; it'd be worth the effort! Some arch-top guitars have a solid, unsplit bridge base, while others are split. In either case, check the bridge fit under normal string tension, since the top and base will flex somewhat. A perfect fit without string tension might be imperfect with the strings on.



I prefer arch-top bridges that do not have metal Tune-O-Matic type saddles; the solid wood top pieces produce a better tone. These solid wooden "saddles" are often staggered for intonation compensation, especially on more modern instruments. The string notches should not be over one-half the diameter of the string in depth—just enough of a groove to keep the string from popping out when plucked. The notch should fit the string's shape and be slightly rounded to a dull peak—not a sharp point— with all burrs removed. I polish the string grooves on rosewood or ebony arch-top saddles with 0000 steel wool to burnish the wood and make it hard.

Arch-top bridges should not be glued into place. They usually leave a mark in the finish, so you'll know where to reposition the bridge



when you remove the strings while cleaning the fingerboard or polishing the instrument. If the bridge seems to pull to either the treble or bass side and the strings won't line up with the fingerboard, the tailpiece may have to be moved slightly to either side. Have this checked by a qualified repairman, since the mounting holes *may* have to be plugged and redrilled. But in many cases, this simple trick often solves the problem: loosen the tailpiece and slide a small shim of wood, paper, cardboard, etc., under one edge of the tailpiece bracket on the same side that you want it to move toward (see drawing at left). The shim forces the tailpiece into position—and it doesn't take much!

While there are some bridge problems that these pages haven't covered, you now know the basics and should be able to see how all the different factors relate. If you have bridge problems, think everything out before trying a repair yourself—and don't be ashamed to get professional help before doing any work that you may regret. For more info on bridge repair, see the Acoustic Repairs chapter.

Setting up a classical guitar

Having the ability to adjust the action on a Fender bass, tweak the truss rod on a vintage Les Paul, or fit a perfect saddle into a Martin D-28 doesn't necessarily qualify a repairman to properly set up a nylon-string classical guitar. There are several major setup differences between steel- and nylon-string acoustics. This section describes classical string installation, correct neck relief, action height at the nut and 12th fret, and the proper shaping of the nut and saddle.

Most of the setup techniques used here apply to adjusting a nylon-string "folk guitar," as well. Braced for nylon strings, these guitars typically have a wider, flatter fingerboard than most steel-strings. Most American and European guitars made before the late 1920s fall into this category, and many of them have bridge pins. During the '50s folk boom, folk guitars were made by Goya, Favilla, Hagstrom, and other manufacturers from abroad. While these instruments are different from the modern steel-string, they aren't grand concert classical guitars, either. If you understand the setup of both classicals and steel-strings, though, you'll be able to handle the folk guitar.

I've set up my share of classical guitars, and once owned an excellent handmade Yacopi. Like many of my peers, I learned Bach's *Bourrée*, studied the Carcassi method, struggled with Fernando Sor, and ended up playing the blues. So I'm no expert when it comes to the concert guitar, but I know experts. I contacted several of the best to get their opinions on setup: William Cumpiano, a student of Michael Gurian and the founder of Stringfellows in Hadley, Massachusetts; Jeffrey R. Elliott, a master luthier and mentor to a thriving community of guitar builders in the Portland, Oregon area; Thomas Humphrey , a world-renowned classical guitar builder from New York city who designed and builds the "Millennium" guitar; and Richard Schneider, who collaborated with Dr. Michael Kasha on taking the design of the classical guitar to new heights. (After hearing a new Kasha/Schneider guitar, Segovia wrote: "To Schneider, in whose hands is the future of the guitar.")

Richard's guitars incorporate the principles of the Kasha design, and his avant-garde instruments are hailed for their beauty, playability, and superior concert tone. Although he sits at the pinnacle of the guitar-building craft, Richard is more likely to speak about design ideas or his students than about himself. He feels that his main achievement may be that he will one day leave behind him more students trained in his methods than any other builder in history. His students include such well-known builders as Abraham Wechter, Gila Eban, Jeffrey Elliott, Mark Wescott, Gregory Wylie, Peter Hutchison, Charles Merrill, John Mello, Italy's Enrico Bottelli, France's Michel Geslain, and Sweden's Fredrik Gustafsson. Schneider's Lost Mountain Center For The Guitar, a non-profit organization for the education of guitar builders and players, conducts an annual seminar starting the first Saturday of

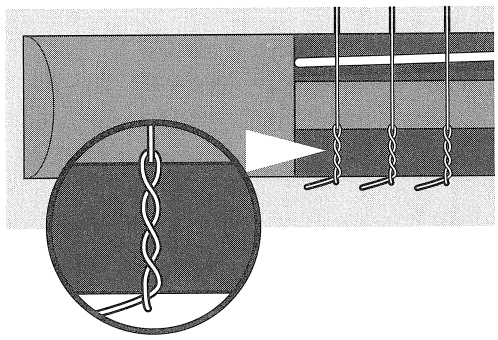
August; for information on attending, contact seminar manager Eric Hoeltzel at Box 44, Carlsborg, WA 98324.

PROPER STRING INSTALLATION

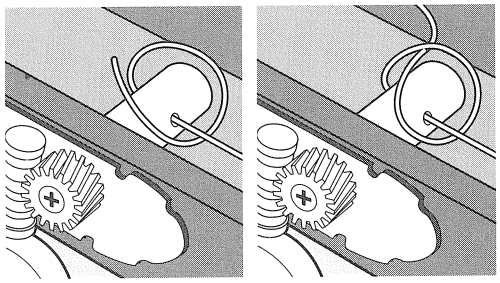
Nylon or "gut" strings (especially the wound bass strings) are more delicate than steel and must be handled more carefully to avoid kinks, nicks, breaks, and unwinds. To prolong the life of nylon strings, take special care while installing, de-tuning, or removing them. The nut slots and saddle crown must be perfectly shaped to avoid cutting the strings, and the ties used to install them at the bridge and tuners are important, too.

Most wound classical strings have a limp end and a stiff end, while the unwound treble strings often have a plain end and a colored one. The limp end of a wound string is simply a result of the manufacturing process; it is not meant to be tied onto the bridge, although many guitarists mistakenly do this because it's easier to wrap. The limp, loose, wrapped ends break sooner, and will not only mar the tie-block inlay, but scar the saddle as well, causing buzzing and intonation problems. Often the treble string ends are color-coded to identify the string tension (red=high; yellow=super high). Don't tie the colored end to the bridge! As Jeff Elliott points out, "The color can transfer permanently to the finish of the top or the bridge, so I either clip it off or use the uncolored end. Whichever end you use for tying, heat it with a match or lighter to create a small ball end that helps it lock. To avoid burning it, remove the string from the flame the instant it begins to contract. If the nylon looks brown or burnt in any way, it will be too brittle, and break off. In this case, cut it off and try again." Ball-end nylon strings, such as La Bella's Folk Singers, are available through your dealer, but they aren't generally used on fine classical guitars. They're used to simplify string installation on folk guitars or lesser-grade classicals.

For the standard wrap at the bridge, work about a 3" length of string through the tie block and out the back side of the bridge. Then bring the string end up and over the tie block, run it under the string, and loop or twist it toward the back edge of the tie block (shown above).



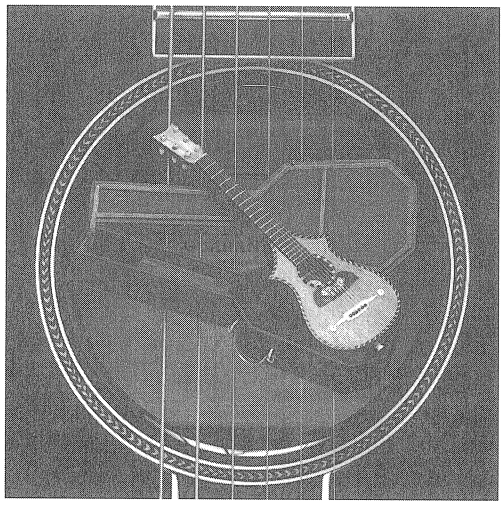
Because the sixth, fifth, third, and second strings have a similar large diameter, two twists are usually enough; the fourth and first strings should have three twists since their diameters are smaller. Regardless of the number of twists, the final twist should be at the back edge of the tie block, where you'll often find a strip of inlay material. The loose end must be tucked in under the string as it exits the string hole in the bridge. This isn't the only tie used on classical bridges, but it's the most common. The sharply trimmed string ends have a tendency to poke into the top after you've completed the wrap, so be sure to snip the string ends to avoid putting dings in the top.



Tying the strings correctly at the tuning key shaft is important, too. For the simplest tie, poke the string through the tuner barrel (roller) twice so that it can't slip, and then wind. This is not the approved method in classical guitar circles, though. Here's the traditional method for obtaining a tie that's good-looking and self-locking: Run the string through the hole, and then back over the barrel and under itself. Then hold the loose end while tightening the string, locking it against itself (first drawing, above). Another similar self-locking tie runs back under itself and then threads up through the loop created by bringing the string back over the barrel (second drawing).

If you work on classical guitars but don't play them yourself, you owe it to your customers to find out as much as you can about proper setup. Visit dealers who handle good classicals, ask questions, and play on the better instruments.

Feel like playing a little guitar? Take a look at this miniature classical guitar by Robert Steinegger of Portland, OR. It's only as long as your finger, but it's actually tunable!



All makers don't necessarily wrap in the same direction or in the same way. William Cumpiano, for instance, believes: "You must have more than one wrap, and it's usually from three to five wraps by the time you get to pitch. Make the wraps around the barrel in the direction that creates the straightest string line to the individual string notches in the nut. Usually the *D* and *G* strings wind toward the center of the headstock, the outer two *E* strings wind toward the outer edges, and the *A* and *B* fall in between." Jeffrey Elliott, on the other hand, says: "Go through the barrel, keeping an inch or two of slack string, and come back up over the top and under the string as shown, but then wrap the string *around itself* twice. Then tighten the tuners, making the wraps around the barrel going *toward* the gears, unless the direction of the string won't get a clean shot from the barrel to the nut. Wrapping away from the gear causes the barrel to act as a lever, putting excess pressure and wear on the gear mechanism and shortening the gear's lifespan by years (especially if the gears are mounted poorly or have any loose components). But different guitars string up differently. The important thing is that a string doesn't touch another string, the channel, or the face veneer while on its way to the nut."

Richard Schneider advises: "Turn the tuning keys until the holes run almost up and down at right angles to the headstock face—maybe with the barrel holes leaning 5° or 10° toward the nut. Run the string down through the hole, up the side of the barrel away from the nut, and back over and under the string. Wrap around the string twice, and then tighten the key while holding the loose end. I don't worry about undue pressure on the barrel or gears, because the tuners I use have a bearing on the shaft end in the headstock center." All of these methods will work. You'll have to experiment to get the correct number of wraps in the right direction so that the strings look neat and miss each other as they go to their respective slots in the nut.

RELIEF AND STRING HEIGHT

"Nylon strings have greater elasticity," points out William Cumpiano, "and therefore a greater vibrating arc than steel strings. To avoid string rattle, they require greater clearance all along the fingerboard. Fortunately, however, nylon strings are comfortable at a higher action setting, and they also intonate properly at a height where steel strings would play out of tune." Since proper classical setup requires a higher action, the need for relief is less than you might think. In fact, the relief necessary to accommodate the vibrating strings of a classical guitar usually occurs naturally from the string tension (90 lbs. of pull) exerted on a perfectly straight fingerboard. Relief is a very subtle measurement, and most makers expect to see from as little as .004" to as much as .040" when measuring the air space between the bottom of the strings and the top of the fret in the area in the 8th through 10th frets. According to Jeffrey Elliott, "Relief generally runs from a minimum of .004" to an average of .020" at around the 10th fret. More than .040" of relief is excessive, and too little relief can sometimes cause 'back-buzz,' where the string is laying on the frets between your fingering hand and the nut, causing a slight but annoying buzz."

"I like to see a neck as straight as possible," claims Richard Schneider, "but some relief is inevitable and perhaps a help. Too much relief can cause *sympathetic* string vibration on the short string length between your fingering hand and the nut. This is a somewhat rare occurrence and is different than the back-buzz that Jeff's talking about, but it's annoying when it occurs. The average relief would probably measure from .020" to .040"." As a result of

string tension, most classical necks take a permanent "set" or forward bow of as much as .020". This doesn't go away even when the strings are removed, so don't mistake this for a warped neck! Again, the higher action is not a problem for the player because of the softer touch used with nylon strings. Some makers may build a slight relief into their necks, while others remove extra wood on the bass side, starting at the nut and running "downhill" to the end of the fingerboard, in the Ramirez and Hauser style. All these methods are correct, and all of the builders questioned approached relief differently.

THE NUT

Bone is the preferred material for making a good nut or saddle for any acoustic guitar. There's no need to go deeply into making a classical nut, since the same techniques described in the section on nut making are used to fit the classical nut. Because nylon strings are so delicate, the correct angle of the string slot to the tuner and a perfectly round shape in the nut slot bottom are even more important than with steel strings. It's especially easy for the wound strings to hang up in a poorly shaped slot, and when they do, they unravel and sound awful—just before they finally break! The classical nut has a flatter top to match the unradiused fingerboard, and like the steel-string, when viewed from the side the nut and string slots must taper at a gradual curve from the back side to the front edge at about a 10° angle.

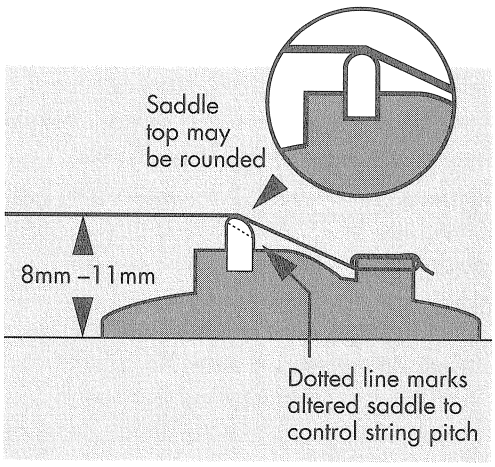
Correct nut height can best be determined by eye, feel, and experience, but the novice can get close by measuring. Richard Schneider says: "The clearance, or air space, over the 1st fret with the string open and coming off the nut should be a little greater than the clearance over the 2nd fret with the string pressed on the 1st fret. A business card measures .005", so use three business cards to measure under the treble strings and maybe five or six business cards under the bass."

Of course, the overall action and height of the bridge saddle has a big effect on nut measurement. Use the same techniques shown in the nut making and saddle sections, balancing one end to the other and working the action down by degree. Another general rule for nut height that works for steel or nylon strings is to press a string at the 2nd fret, looking to see a slight clearance between the string and the 1st fret; as long as there is some clearance here, the open strings shouldn't buzz. The clearance should increase gradually from the high- to the low-*E*, because the lower wound strings must sit from .015" to .030" higher in the nut than the treble strings to avoid open-string buzz. Overall string height at the nut shouldn't get too low, since there's a strong tendency for nylon strings to buzz sympathetically between the fretted note and the nut behind where you're actually playing, just as they would from too much relief! Here's a final general rule for nut height: Measure the air space between the string and the top of the 1st fret, looking for a gap of ½ mm (.020") under the treble-*E* and around 7/10 mm (.030") under the low-*E*.

A traditional classical guitar fingerboard is flat from side to side, although some modern makers are introducing a very slight radius to make it easier to play barre chords. "This is a very gentle arch that's imparted with a plane," says Cumpiano. "It's not greater than a 1/32" offset at the fingerboard edge. It makes the instrument easier to play, and probably lets a player get away with a little bit less technique." The classical guitar's saddle should be flat, too, or match the shape of a slightly arched fingerboard. As with the nut, set the saddle action lower on the treble side, following the same 1/32" rise from treble toward the bass. Some makers taper and thin the fingerboard on the base side in order to keep a more regular saddle height across the bridge (this creates a more even angle on the string which exerts a more even tension on the top). Other makers who feel that the bass strings need to break at more of an angle than the treble strings disagree with this technique, since it eliminates that option.

ACTION/STRING HEIGHT

To set the action, use a small ruler at the 12th fret. Measure the air space from the bottom of the string to the top of the fret. Different builders prefer different readings under the two *E* strings: Elliott's preference is 3 to 3½ mm



under the treble, and 4 to 4½ mm under the bass, while Cumpiano favors ⅛" under the treble and 5/32" under the bass. "A high action for a classical," he adds, "would be 5/32" treble and 3/16" bass." Schneider describes: "When fretting the string at the 1st fret, measure 3 mm under the treble and 4 mm under the bass. A good concert player can handle this action, although some prefer to have the action higher. After adjusting the action to these parameters, I make two more saddles: a low one measuring 2½ mm treble to 3½ mm bass, and another one that's 3½ mm treble to 5 mm bass. I also cut a second nut with the string spacing closer by 1 mm. These are put in a little walnut and rosewood box that I deliver with each instrument."

Traditionally, the classical saddle isn't shaped quite as round as a steel-string's, because of the nylon string's tendency to unravel or break when it meets a sharp edge. Instead, the saddle is often tapered smoothly towards the front edge (above) so that the string "takes off" gradually, with full support from the saddle shape to avoid string breakage. This method of shaping is only valid if the exact compensation has been calculated into the placement of the bridge; otherwise the peak of the saddle may have to be slightly altered to get the most accurate intonation. Many classical builders prefer to use a gently rounded saddle top; either method is correct. The saddle should fit snugly into the bridge slot and have a well-sanded and polished top surface for optimum tone. There should be no sharp edges or notches cut into it, although John Williams, a great classical guitarist, has been known to prefer a notched saddle.

Jeffrey Elliott points out that the builder can control tone and string tension by altering the saddle's angle and thereby changing the pitch of the string to the tie block (left). This subtle refinement is probably beyond the scope of our needs, but it's the combination of such little subtleties that make one guitar sound better than another. Jeff also states that the height of the strings from the top is extremely important; from the bottom of the string where it meets the saddle to the guitar's top should measure somewhere between 8 mm to 11 mm for most instruments.

Thomas Humphrey had this to say about setting up the classical guitar: "Dan, what you have to remember is that all guitars move a great deal between summer and winter, especially new guitars. All of the measurements given here are fine, but there are very few players who are going to accept a "factory" setup until they've had time to feel it for awhile. Before people are even out of the shop they want two saddles—a high and a low. They never leave it alone! So it doesn't matter *how* the maker sets up the guitar. As long as a classical guitar is set up within reason (an *average* setup) you're fine. Until a player gets the strings under their fingers, action setups don't mean anything. You have to give a lot of room to the player. The better the player, the more they'll want adjustments made.

"No two guitars play the same way—not even from the same maker. Each may require a slightly different setup. It depends on things like the shape of the neck in the back, the curvature of the fingerboard, and of course the scale length. Long-scale and short-scale guitars must be set up differently because of the difference in the string tension, and there is no scale length standard. 650mm is the most common scale length, 670mm is the longest I've heard of, and the shortest *I've* ever made is 620mm."

STRING RECOMMENDATIONS

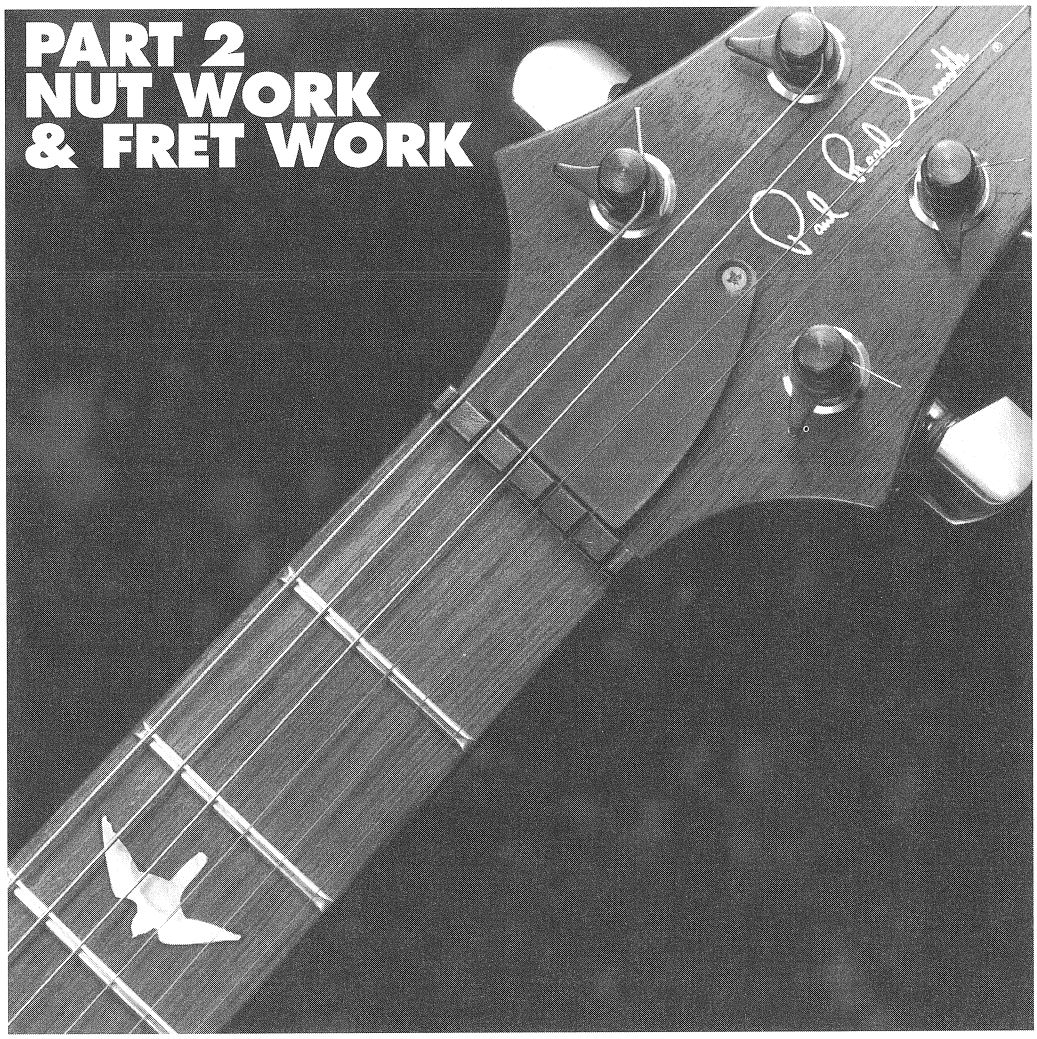
What brands are good, and how often should they be changed? Cumpiano points out that a recitalist often changes strings every two or three days, and always before a performance. String deterioration has a dramatic effect on intonation, and sadly enough, classical strings are not only quite fragile, but expensive. Old strings lose pitch accuracy and tone. Cumpiano cites D'Addario Pro Arte Hi-Tension strings as a modern, well-built set, and he also uses Savarez Blues and Whites. Schneider prefers D'Addario Pro Arte, Savarez Crystal Solis, and GHS, which are all high-tension strings. "You might want medium- to low-tension strings for a recording situation," he adds, "because they're easier to finger, and some instruments do sound better with low tension." Kurt Rodarmer plays a Schneider/Kasha guitar and only changes his treble strings every six to eight months, since they get rock-hard and stay that way, creating the best sound. He changes the bass strings every other week during normal practice, and always two days before a concert. (I encourage string manufacturers to market sets of bass strings only, because everyone always has scads of extra trebles!) Elliott favors both high- and normal-tension D'Addario Pro Arte and Savarez Alliance in Red or Yellow, which, he says, "are made of a new material that is smaller in diameter than most others, has less tension, provides a good tonal variety and response, and is extremely accurate and clear sounding." R.E. Brune, a famous luthier based in Evanston, Illinois, has recently begun importing the excellent Hannabach brand. Many players have been extremely impressed with these strings.

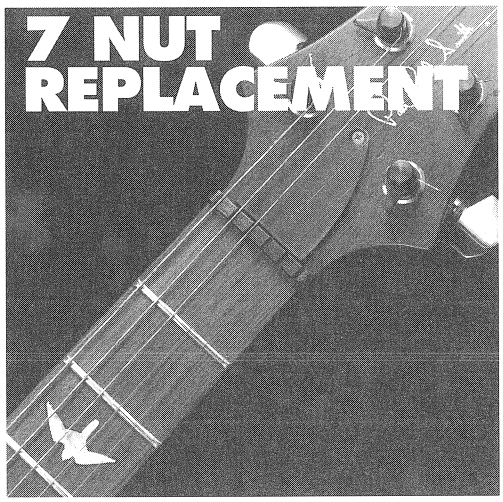
For more detailed information on classical setup, read the books listed in the Recommended Reading section, especially *Guitar Making: Tradition and Technology* by William Cumpiano and Jon Natelson.

AUTHOR'S NOTE

Tom Humphrey's 'Millennium' design incorporates a sloping sound-board and an elevated neck. These two factors combine to create a greater string-to-sound-board angle, thus producing a different load on the soundboard (similar to that of the Harp). This angle also creates a more resonant sound, and is one of the features which make Tom's guitar so playable.

The other feature which struck me is the elevation of the fretboard from the sound-board. Because the player's hand is no longer obstructed by the body at the 12th fret, greater access is achieved and the instrument is more playable in the higher registers. Mr. Humphrey recieved a mechanical patent on this innovation from the U.S. Patent Office in 1987. The Millennium may be the first universally accepted new design in the classical guitar since Torres set the standards in the mid-1800's.


PART 2
NUT WORK
& FRET WORK



Twelve steps to replacing a nut

Many players are anxious to work on or make their own nut, since it's one of the guitar's most important parts, in terms of action, sound, and playability. While its perfect fit is best left to qualified repairmen where your favorite guitar is concerned, it's OK to develop your nut-making skills on inexpensive imports and old yardsale specials. This chapter describes the necessary nut-making tools (many of which you can make yourself), the best materials to use, and the basic steps involved. If you go about the process slowly, work on instruments of lesser value, and make a small investment in certain specialized tools, you should eventually be able to handle nut making like a pro. Remember, be patient and read the whole story before tearing apart any guitars—and don't wreck a good one while you learn!

Nuts need to be replaced for a variety of reasons: the string slots are too low and cause buzzing at the 1st fret, the string spacing is irregular or too wide or narrow to suit your taste, or the guitar isn't producing a strong, clean sound (this is most often caused by plastic nuts). Perhaps you've found a used guitar that would play, except for a chip right on a string groove at the nut. It doesn't take someone with a Ph.D. in guitar repair to know when the nut has to go—just follow your senses. In most cases, if your guitar plays well on the fretted strings and only annoys you on the open ones, the nut's just worn out. If you were happy with the nut's general shape, you can remake it, trying to copy the old nut's string width and spacing as closely as possible; simply leave the strings higher than before to eliminate buzz. On the next page is an outline for nut making, followed by advice on specialized tools that you'll want.

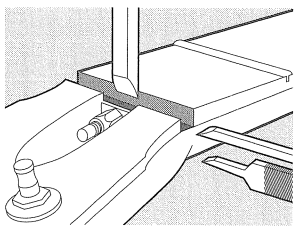
Bone is white because it's bleached. You'll also find a lot of yellow and off-white bone. I've been very happy with the blanks I get from Stewart-MacDonald and Luthier's Mercantile.

TWELVE STEPS TO REPLACING A NUT

1 Remove the old nut.
2 Clean nut slot of glue and residue, and square it up.
3 Choose new nut material and rough-in the blank to fit the cleaned slot.
4 Lay out string spacing.
5 Rough-in approximate string slots, without going too deep.
6 Trim off excess nut material from top as slots get deeper.
7 Lower and shape string slots, moving strings side to side, if needed.
8 Trim off excess nut material, rough edges, and overhang.
9 Final-sand and contour the nut's shape.
10 Polish with a soft rag and rubbing compounds (especially the bottoms of string slots).
11 Final-check the string height and shape, and string to pitch.
12 Glue in nut (with strings on, for clamp pressure).

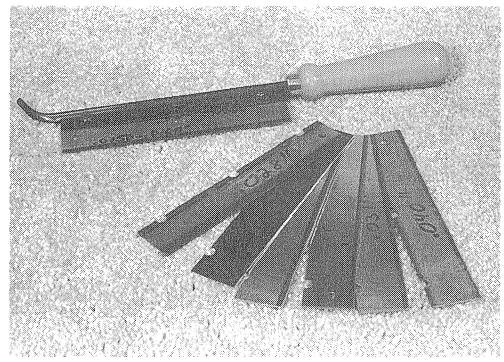
TOOLS

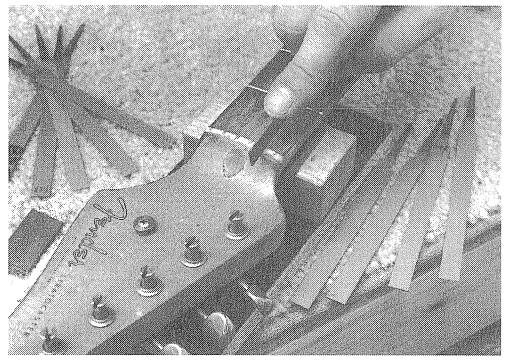
The right tools help make the job easier. You can make many of them yourself, and specialized items can be found at the luthier supply stores listed in the back of the book. Other items are available from hardware stores or wood-shop suppliers.



A sharp chisel is great for paring (shaving) and scraping glue off the fingerboard's end; I like a ⅜" or ½" bench chisel for this job. A ⅛" chisel that's ground slightly thinner in width is also good, especially for getting into a Fender-style nut slot (see drawing at left). You'll find a smooth mill file handy for shaping the nut, cleaning away old glue, and helping with squaring-up. A small (6") mill file is also quite handy, since it's thin enough (.115") to file inside a Fender slot for squaring-up, and the file's tang becomes a great scraper, chisel, etc., when sharpened on a grindstone (note the tang-converted file in the drawing). Specialized "nut-seating" files (they fit Fender, Gibson, and Martin slots) are available.

A set of feeler gauges is a help when measuring action height from the string's bottom to the top of the 1st fret. If possible, buy the kind that you can take apart by loosening a screw. In





fact, feeler gauges are a must around any shop, for all sorts of uses. We'll use them throughout this book, so buy a full set.

Small "razor-saws" are often used to start nut slots, and in some cases to do the actual nut-slotting. X-acto makes a great razor-saw set with three interchangeable saw blades of .012", .013", .014" in thickness. BLITZ-Saw blades (top photo) come in six sizes ranging from .015" to .040" and can take over where the X-acto saw leaves off. Saws are great for roughing in a slot depth in a hurry, but I prefer to finish up with the round-bottom nut files mentioned below.

An X-acto knife (or other brand) with #11 blades is also a must, since it's used to score the finish around the nut during removal. These saw/knife sets vary in size and price and are available at many hardware stores and guitar supply sources.

Specialized nut-shaping files are available from Stewart-MacDonald, Luthier's Mercantile, and the C.F. Martin company. Custom-made for getting into nut slots, these round-bottomed files have smooth sides that allow you to cut the nut-slot bottom, but not the slot's sidewalls. These "Precision Nut Files" (above) have accurate, well-shaped, round cutting edges, and include ten files ranging from .010" to .058".

Full sets of files are expensive (around $70), but worth the money if you're serious about getting into the business. The ten files that are my favorite can be purchased one at a time, and four which make a good starter set are mentioned shortly under "Cutting String Slots."

Don MacRostie and I have been working on a new nut file with edges coated in industrial diamond. Having no teeth, they don't "run off" the intended line as toothed files will. I hope these become available in the future, because they work great!

You'll need a 6" stainless-steel rule, preferably the hardware-store variety made by General. I've mentioned this tool often; everyone should have one. Notice that the fractions are converted to decimal equivalents on the back side; this is handy for string spacing. A dial caliper is always nice to have, but certainly not a must. Even the inexpensive plastic kind is plenty good enough for our needs. Nut spacing templates, with the string spacing already laid out (see below), are also available.

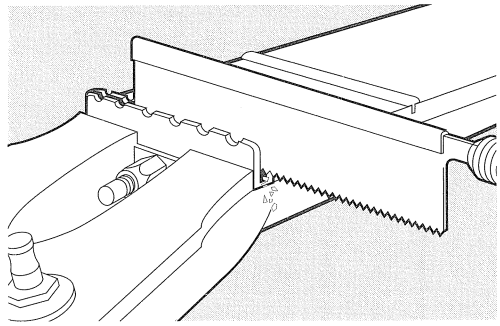
Whenever you're making or adjusting a nut, remember that string height at the nut is directly affected by the height at the bridge. You may need to work back and forth a bit from the nut to the bridge, by either raising or lowering an electric guitar's adjustable inserts, or by filing, shimming, or replacing an acoustic guitar's saddle. You should be basically satisfied with the action and playability of the guitar as it is (with the exception of buzzing from nut slots that are too low) before making a new nut, so that you don't discover at the job's end that the bridge was too high or low to begin with. Now, on to making a nut.

REMOVING THE OLD NUT

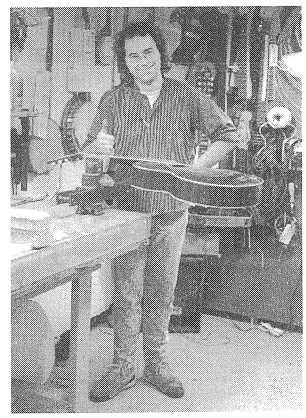
Before removal, score completely around the old nut with a sharp X-acto knife or razor blade. This way, if the finish starts to chip upon removal, the chip will stop at the scored line. Most often the nut comes unglued after being tapped with a block of wood and a hammer. Firmly but gently tap from the front (fingerboard side) of the nut, and then tap from the rear in the same fashion. Do this back and forth until the nut "rocks" out. Once loose, grip it with your fingers and pull it out carefully. I can't overemphasize the need to watch for finish chipping! It's a risk you'll have to take. Many imported guitars with thick polyester finishes are hard to score—but not impossible. Wear safety glasses while scoring the lacquer or polyester and while knocking the nut loose. With Fender-style guitars, you'll have to grip the nut with some end nippers or pliers after gently loosening it by tapping, and then pull it out like a tooth.

Here's a nut-removal method from Flip Van Domburg Scipio, head of the Mandolin Brothers repair shop in Staten Island, NY:

"When removing a nut from a guitar with a bound peghead—or one with a deep nut-slot or heavy lacquer—I occasionally need to 'collapse' the nut instead of trying to knock it or pry it out. Saw through the nut with a fret saw until close to the bottom and then you can squeeze it together—pulling it away from delicate binding, finish, or wood."



Note: I took a pair of my flush ground fret nippers and ground the sharp jaws flat and dull. This works great as a "crusher" and also as a gripper for pulling saddles too. —Dan



Flip Van Domburg Scipio

Once the nut's out, clean any glue or residue from the nut slot (the groove that held it in the neck). Even on cheap guitars, the nut slot is generally uniformly shaped at the factory, but it needs to be scraped clean of residue for a good-fitting blank. Common nut thicknesses range from ¼" to 3/16" (for Martin, Gibson, Guild, and their acoustic clones) down to ⅛" (for Fender-style electrics). A variety of files and tools will fit in the slots for cleaning. I use a sharp chisel to remove any glue from the fingerboard's end grain and to trim any sticky stuff from the front edge of the headstock overlay. Held vertically and used with short strokes as a scraper, a chisel can be great for cleaning the bottom of

Many new nut blanks have tiny pits and crevices that you might not notice until the buffing stage. These holes may fill with compound or finger dirt, making the finished product look funky. For a smooth-looking job, try filling the holes with super glue before handling them.

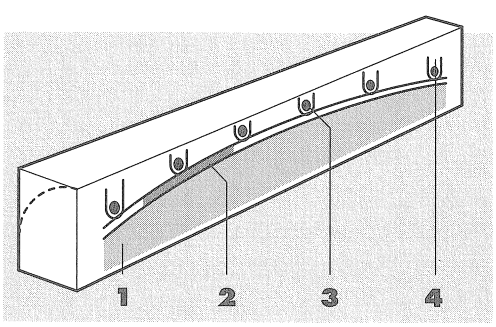
the nut slot, too. The nut-seating files described earlier work the best. If you file the bottom of the slot, be sure to lightly file the lacquer's edge first, so that it won't chip as you begin to file the wood. To avoid pushing a chip of lacquer off the neck, always file in from each side toward the center.

ROUGHING IN THE BLANK

I prefer bone as a nut material and no longer use commercial ivory, which necessitates the slaughter of elephants and other mammals with tusks. Don't even mess with sellers of "legal" ivory—they're lying. Bone makes an excellent nut, and synthetic Micarta is also good (begin with Micarta as you're learning—it's cheaper).

Start with a blank that's bigger than the actual slot height, length, and thickness, and slowly bring it down to size. Use the saddle-making techniques described in the Acoustic Adjustments chapter as a guide for squaring up the stock and getting it to fit the slot. (Quick repeat: Flatten one side against a smooth file, mark out the desired thickness, and then sand, file, or belt-sand the opposing side to uniform thickness.) Be sure the bottom is shaped exactly like the slot; Martin nuts, for example, have an angled bottom. Leave a ⅛" overhang on both treble and bass ends to allow the nut to be shifted from side to side as you're laying out and filing the string slots. That way, if you happen to get a bit off on your string spacing, you can tap the whole nut towards treble or bass and relocate the string slots.

The nut should press into the slot and fit snugly. Viewed from the side or end, the blank should be gradually rounded toward the front edge (note the dotted line in drawing below). If it pleased you, copy the shape of the old nut. When the blank fits, trace the fingerboard's shape (radius) onto it from the front side by running a pencil over the fingerboard surface.



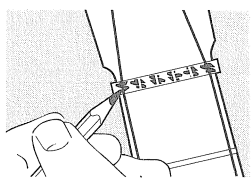
Remove the blank and finish laying out the nut in pencil by adding the thickness of the frets (say .035"), the height of the strings from the fret top, the thickness of the string itself, and a little extra for good measure. Most players prefer an action that's higher on the bass side than on the treble. (This treble-to-bass rise is illustrated in the previous two chapters.) Use care when taking the blank in and out, so you don't chip the lacquer or wood as a result of the tight fit.

This is a good point at which to take a break, and review nut making up to this point. Spend time gathering your tools, and practice a nut rough-in on something that you know you can't ruin. Then we'll cut the string slots and finish the job.

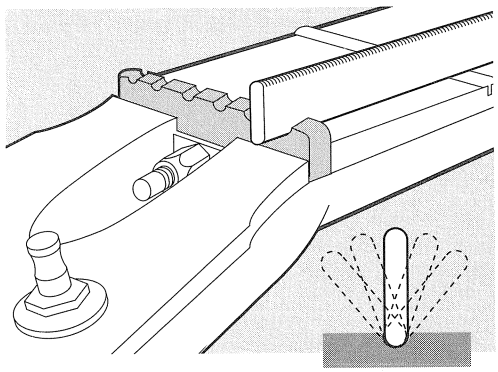
Cutting string slots and finishing up

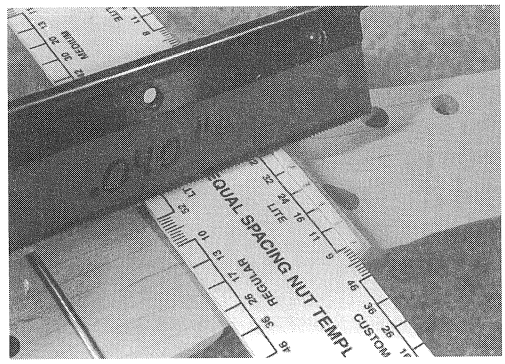
We just went through the steps for making a nut, described some necessary tools, and got through the roughing-in stage. Now we'll carry on with the job. Good luck!

Before proceeding any further, lay some masking tape over the headstock face and on the fingerboard between the nut and 1st fret to protect the wood and finish from an accidental slip of the file. Use as many layers as possible without getting in the way of your work. On older guitars with brittle finishes, it's best to use the less-sticky draftsman's tape, which won't pull off the finish as badly.



Install the two outside *E* strings as far in from the fingerboard's edge as you like for spacing. Do this by looking down from directly overhead. Mark the outsides of the strings on each side of the nut with a pencil, and file starter notches to hold the strings. The best tool for this is a thin X-acto razor saw; it's also perfect for the actual filing/shaping of the slots for the high-*E*, *B*, and sometimes *G* strings. In general I use a specialized set of nut files that cut only on the thin edge and leave a round-bottomed slot. While





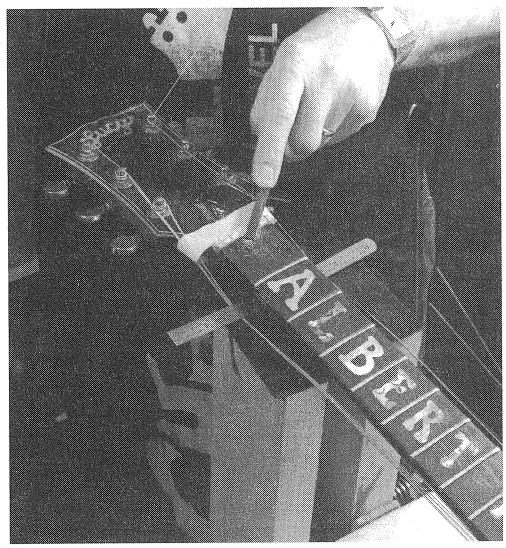
It's hard to find perfect bone blanks, so don't throw out the pitted blanks; just save the really good ones for your primo jobs. And remember: Everyone else is faced with the same situation, so make do with what you have and don't complain to your suppliers—they're doing the best they can!

the full set costs about $70 and is actually a great investment for anyone doing much set-up work, you can begin with three files (.016", .025", and .035"). These can cut most nut slots if you roll the file for extra width as you cut. This "roll-filing" action is the way to file slots. By using a file slightly smaller than the intended notch width and rolling on the forward stroke to widen the outside walls, you have more control and the file won't stick in its own notch.

Once the outer strings are set in position, measure between their centers with the 6" rule or a dial caliper. Divide the distance by five to get an *approximate* equal spacing between all six strings. Use a calculator, because you'll be dealing in decimals—it's rare to find a nut width that's divisible by fractions. For example, if the outer *E* strings measure 1⅜" center to center, the decimal conversion is 1.375 divided by 5, which equals .275 from string to string. I refer to this measurement as *approximate* because the lower wound strings, being fatter, would actually be closer to each other than the unwound treble strings when spaced exactly evenly. Use the *exact* measurement only for the initial layout, file very light starter slots, and then put on the remaining four strings. Now adjust the final between-string spacing by eye, as you file and lower the strings into the nut blank. Note: I repeat, dividing by five gives equally spaced string-to-string *centers*. I prefer equal spacing between the *outside* of adjoining strings, not equal spacing between their centers. A new tool to help you achieve *equal spacing between strings* is the Compensated Nut Spacing Template, which has the diameters of the strings factored into the scale (photo above).

When the slots have all been started just enough to hold the strings so that you can check them by eye, switch to your nut files, X-acto sawblades, and/or ground-down, fine-toothed hacksaw blade. File at a back angle to the nut's front edge, so that the string will have decent downward pressure. To play in tune, the string's actual contact point should be at the very front of the nut. On guitars with angled-back headstocks, which are the most common, you basically follow the angle of the headstock itself. With slab-neck Fender-style guitars, you won't file as steep a back angle, so just file the appropriate angle needed for each string-post.

File the slots one at a time, starting with the high-*E*. Loosen the string and lift it out of the slot as you file. Then replace the string, tune it to pitch, and check your work. Expect to go back and forth from treble to bass several times before the slots get close to their final depth and shape. You'll need to keep filing the nut's top down as your strings get lower into the blank. In general, you want the strings to sit in round-bottomed slots, filed to the shape (diameter) of each string, and no deeper than one-half the string's diameter.



Sometimes you'll work hard making a perfect nut, and right at the end of the job you'll go too low with your file, causing an open string to buzz at the first fret. You'll want to tear your hair out! It's called "blowing the nut," and we all do it. Either shim the nut, or start a new one. Sorry!

My friend Don MacRostie, who's an ace mandolin designer and repairman known throughout Ohio for his Red Diamond instruments, taught me the following method for knowing when the strings are dropped enough in depth. Here we use the feeler gauges described in the tool list given in the roughing-in section. You need to remove the protective masking tape from the fingerboard to do this.

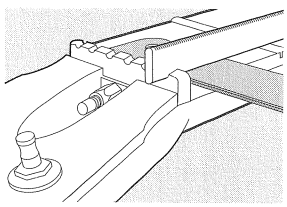
1 Measure the height of the first two frets, from the fret's top to the fingerboard, by laying a straightedge across the two frets and sliding different combinations of feeler gauge blades under it until they just touch the straightedge. Record this measurement (let's say .035" for an average, somewhat worn fret height).

2 Add to this from .005" to .010", or any figure you come up with after experimenting. New total: .040" (.035" frets, plus .005").

3 Stack up a number of feeler gauges that equal the total measurement (.040"), and hold them against the front edge of the nut while you file at a normal backward angle down to the metal. When your razor-saw, nut file, or home-made hacksaw blade file contacts the hardened steel—you'll feel it instantly—it's time to stop.

Although I've described how to measure and lay out the divisions of the strings before filing, I usually do it by eye. Learn to trust your own eye.

The nice thing about this method is that you can control the drop of the string and avoid accidentally going too low. Also, when you find a good measurement for high-*E* and *B* strings that is low and comes close to your final action, you can increase this amount by .002" or so as you go across the radius of the board toward the bass side, slightly raising these strings more than their treble-string counterparts. When you find good average measurements, record them as a guide to use some other time.



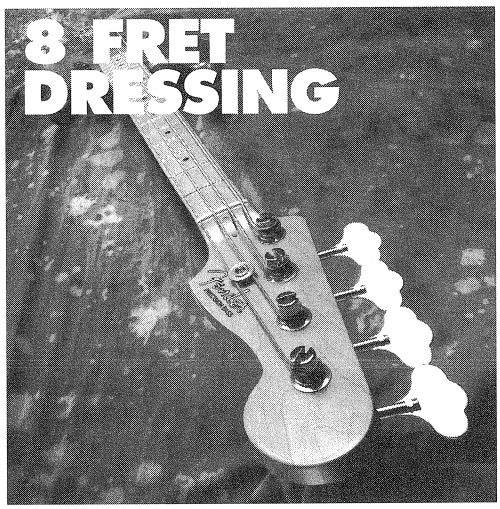
When the string slots are well spaced and deep enough, do the final shaping and finishing. Using a very sharp pencil, mark the excess nut-blank overhang and trim it off with your razor-saw (file or sand if you prefer), leaving a slight bit of the pencil line showing so that you can file and smoothly sand it away without chips. For the final time, sand down the top to eliminate any too-deep slots, finish rounding and shaping the nut to look like your original or the picture in your mind's eye, and sand off any scratches using 320-, 400-, and 600-grit wet-or-dry sandpaper, in that order.

If you have any really deep scratches, you may find it easiest to remove them with your smooth mill file. Buff the nut on a soft rag smeared with a buffing compound and then a polishing compound, such as Meguiar's Mirror Glaze #4 and #7, in that order. I like to high-polish the slot bottoms with 1000-grit "Finesse" sandpaper wrapped around my nut files or razor-saw. These buffing compounds and 1000-grit paper are available at most auto parts stores and from many guitar shop suppliers. Finally, dry-buff the nut surfaces on a clean dry rag. Care should be taken when sanding, smoothing, and polishing the nut. Stay on the exposed surfaces and lay off the bone that actually fits into the nut slot—too much buffing here can create a loose fit when it comes to the gluing-in.

To be sure you have the action the way you like it, string the guitar to pitch before gluing the nut. Recheck your string height and the relationship between nut and bridge. Don't be surprised if you have to take the nut in and out of the slot (stringing to pitch, as well) as many as a dozen times while you're learning. Expect some string breakage, too, from the constant tuning down and up to pitch. Most pros usually have a nut in and out of an instrument at least four times before completion, so don't feel bad.

If the final fitting meets your approval, glue the nut into place using a couple of light dabs of hide glue or white glue. I avoid using my beloved Hot Stuff super glue here, because its instant setting time won't allow you to move the nut from side to side when lining it up. Apply the glue lightly to the front wall and underside of the nut, set it in place, and quickly snug up the strings to help hold it. After the glue has set (one hour for a white/yellow glue such as Titebond, and three or four for a hide glue), you can tune to pitch and you're back in the business of making music.

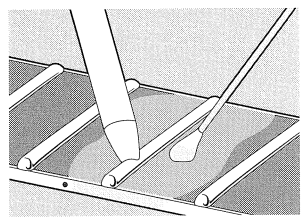
Be sure to read between the lines here, knowing that I can't describe every approach to nut making, nor all the tools that can be used, without writing a book on just that one subject! This is enough information to help do-it-yourselfers do a better job, and to educate those not interested in doing their own setups so they're better prepared to shop for quality work.

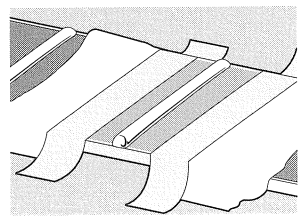


Loose frets

Before you can learn to dress frets (which is one of the main lessons in this section) you should make sure that you don't have a fingerboard full of loose frets and loose fret ends. It's hard to level and re-crown frets that are loose because they press down as the file passes over them, and pop right back up when it goes by. Loose frets are common, even with good fretwork on great guitars. A lot of fret buzz is caused by loose fret ends, which are hard not only on the ear but also on the fingers. While a complete fret job is sometimes needed to correct buzzes caused by warps, twists, and worn-out frets, just as often the problem can be solved by gluing down the end of the one fret that has lifted. In the old days, the resetting of a raised fret end was difficult and time-consuming. But that was before super glue. Now the average guitar player can easily and safely solve this problem.

A fret end can rise for a variety of reasons. The fret slot may be too big, or the fret tang (the part that's driven into the fingerboard slot to hold the fret in) could be too small. Rising fret ends may also be caused by insufficient glue, or wood that has shrunk: some frets are held in with glue as an aid, while others are hammered in dry, letting the small beads on the side of the tang do all the holding. Dirt, grease, and oils may have loosened the glue or softened and weakened the wood that holds the fret. Here's a quick and easy technique for tamping down those high fret ends:





Begin by finding a wooden dowel at least ¼" in diameter and 6" long. Carve or file a slight notch in one end. This dowel is used for pushing the fret end down flush on the fingerboard while you wax the fret and its surrounding fingerboard area to aid in the cleanup of the glue. The stick also holds the fret in place while the glue sets.

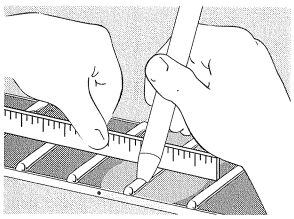
Next, lay a sheet of paper on each side of the bad fret and tape it down to within ½" of the fret. Wax the exposed fingerboard and fret edges, going over the side of the fingerboard

Always wear safety glasses when using super glue. Remember that it can bond your fingers together, and keep a bottle of solvent handy in case of accident.

or binding, as well, in case any glue might run over onto the neck. Use a Q-Tip to apply any sort of paste wax. Don't load the Q-Tip with wax; twirl it in the wax and wipe off any lumps. When you've finished waxing, release the fret. It should pop right back up, with no wax having gotten under the fret where you want the glue to do its work.

If you have more than one loose fret end (and often you will), don't try regluing more than one at a time. Use Hot Stuff Original Formula, which is water-thin and able to penetrate deep within the fret slot and tang area. You'll also need a bottle of accelerator to speed up the drying time and cause an "instant" cure. The reason we covered the rest of the fingerboard is so that all the frets don't become activated by the accelerator's effect, which lasts about 15 minutes.

The guitar should be fairly immobile while you're working, so block the neck with some books or something firm for it to press against. Apply a drop of glue to each side of the loose fret along the fingerboard edge as far back as your eye tells you it's loose, and watch it disappear as it runs deep into the problem area. With a soft rag or tissue paper, remove any wet glue that doesn't run under.



Immediately follow with a squirt of accelerator on each side of the fret, and then quickly but smoothly peel off the tape and paper. While the glue is accelerating, it's wise to have your wooden press-stick in the other hand, ready to press the fret down. While pressing the fret flush to the fingerboard, you can use a straightedge or flat object to help judge when the fret is level with its nearest tight fret. The glue should set within 30 seconds. Don't press the fret lower than the frets on either side, since this will result in a fret that's too low and subject to buzz. The actual gluing and accelerating must be done swiftly and efficiently, so first practice the operation in a dry run. Follow this time schedule: Apply glue and clean up excess—5 to 10 seconds; squirt accelerator—2 or 3 seconds; remove tape— 2 seconds; press fret down and level with straightedge or block—5 seconds.

In less than a minute the fret should hold, sometimes leaving a small bead of squeezed-out super glue showing along the fret/fingerboard edge. Remove this glue with a sharp-pointed tool (pin, X-acto blade, chisel, etc.). Any glue that might remain on the waxed area of the fingerboard should be removed by scraping lightly (lengthwise with the fingerboard rather than across-grain) with a razor blade, and then polish with 0000 steel wool. If you still have a slight buzz, you may need to slightly level the fret with a smooth mill file or block of wood wrapped with #400 sandpaper, or use the Koontz radius blocks described in the next section.

If you have any trouble getting the fret level or if you feel that you didn't glue it properly, use a soldering pencil to loosen the glue bond and try again. Heat breaks a super glue bond in the same way that it loosens most any glue, including epoxies. Caution: Heat causes some glues to vaporize. Do not breathe the fumes or allow them to get into your eyes! Try to avoid getting into this situation. The second time around on a given fret may be more difficult because the hardened super glue is still under there. Don't use too much glue, and be especially careful not to let the glue run onto the neck. If it does, wipe it off immediately with some lighter fluid, which you should keep handy.

Wear safety glasses when using super glue, and remember that it can bond your fingers together. A short while back, a fret sprung up on me when my push-stick slipped, spitting super glue onto my prescription plastic-lens safety glasses. The glue hardened instantly and permanently. I had to buy a new pair of glasses, but my eyes were spared. Of course, avoid splashing a guitar's finish. Buy a bottle of solvent for cleaning glue from your fingertips and to help separate them in case of accident. Never use this solvent to remove glue from a lacquer finish, since it dissolves lacquer. Practice with the super glue and accelerator on objects that you don't care about before trying a repair. This will give you a feel for the setting time and show you how quickly it runs.

In extreme cases (with much sweat and oil worked under the fret), this method may not work, but it's worth a try; if it doesn't work, a partial or complete refret may be needed.

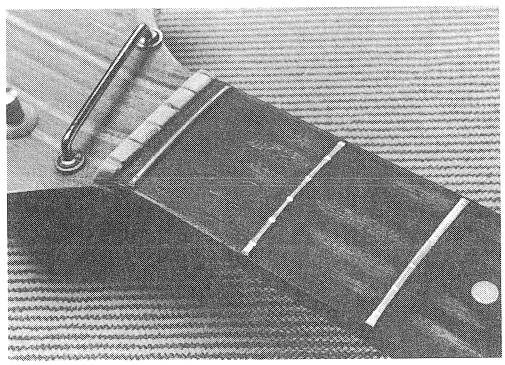
Fret-dressing basics

Fret dressing is one of the most common reasons a guitar ends up in the repair shop, and while you may never attempt your own fret dressing, this chapter will help you better understand what's entailed in repairing an instrument that plays poorly because of fret problems.

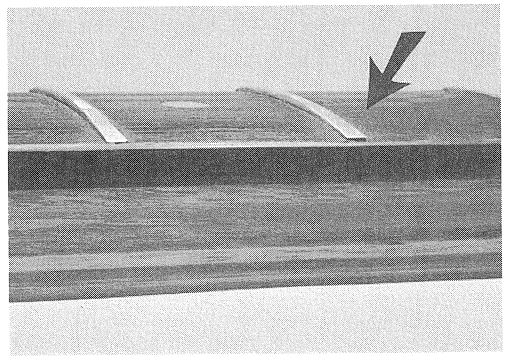
Be sure you understand the fingerboard/neck evaluation and neck-rod adjustment explanation given in the Getting Started chapter before you attempt any fret work. And before you touch a file to your frets, read this chapter completely, since it teaches the fret-dressing process, as well as helping you determine whether a partial or complete fret job is needed. Even if you're squeamish about dressing your own frets, you can use this information to relate better to your repairman or to help judge a guitar that you are considering for purchase.

Fret dressing refers to the leveling-out and re-rounding (or "crowning") of high, low, or worn spots on frets; these can cause buzzes and "noting out"—notes that won't play cleanly. Basically, here's what's involved in the process: Leveling is first done with a smooth, flat mill file, followed by 220-, 320-, and 400-grit sandpaper for smoothing. Next, the fret tops left flat by the leveling operation are re-rounded with a small triangular file or a fret-rounding file. Any jagged fret ends along the fingerboard's edge are rounded now, too. Finally, a good polishing with fine sandpaper and steel wool gives smooth, buzz-free frets that are a dream to bend on.

Many new guitars come from the factory with the frets leveled, but only a cursory job of crowning has been done. This is often why some factory-fresh guitars play less than perfectly. Since fret dressing is tedious and time-consuming manual labor, a deluxe job at the factory would raise the instrument's price. Crowning is necessary, though, since the flat tops of the frets will otherwise have more surface area for the strings to buzz against as they vibrate. Flat frets also cause problems in setting the intonation (since the strings can play sharp or flat to either side of dead center) and make the strings harder to bend due to the increased friction.



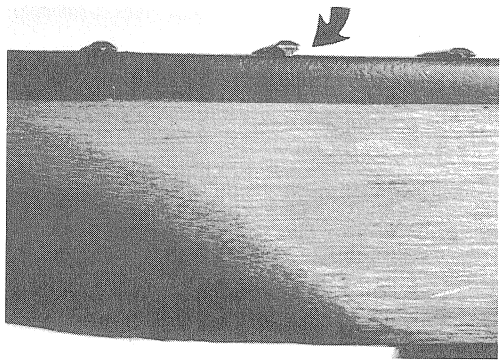
Guitars that have been played on for a while can develop grooves or pits in the frets, especially in the first five (above). If the grooves are too deep, you don't want to file all the good frets down to the level of those few bad ones for the sake of flatness and a level fingerboard. A general rule: When a pit or groove has been worn much lower than a third of the fret's full height (and definitely if the wear approaches the fret's halfway mark), have the guitar looked at by a repairman. You may be advised to have the worn frets replaced with matching fretwire (called a "partial refret") or to refret the instrument completely. Take the repairman's advice, but get several opinions.

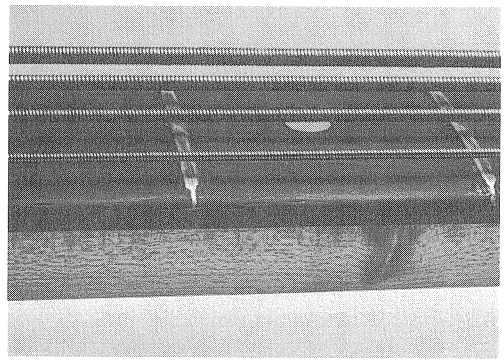


Frets that are worn too flat can be found on any guitar—from inexpensive imports to fine American-made models. Rather than being pitted, the tops of these frets are extremely low and flat (above). This can be caused by years of playing or by a poor fret job that someone tried to correct by leveling without taking the extra time to crown. Although you may

Hot Stuff's yellow-label Super T can be used for loose frets, too. Practice on junkers, by all means. If you use Hot Stuff's red-label Original Formula, you don't have to use accelerator. Try it both ways.

Before touching a file to your frets, read this complete chapter!





eventually need a refret, these low frets can be rounded with a lot of work. Find a bargain yardsale special with over-flat frets and practice on that.

Loose frets or a fret that is taller than those surrounding it will also cause a string to "note out"—in other words, you can't hear the intended note at all because the string is fretting at a higher fret. In most cases, this is caused by the fret working loose (above); it needs to be reseated. Although this is quite easy to do, I advise you to take your guitar to a repairman. It can probably be fixed on the spot. (Thanks to super glue, instant repairs can often be performed while you wait.) After you've gained some experience, you can try reseating a fret yourself by following the information given at the beginning of this chapter in the section on "loose fret ends."

The opposite of a too-tall fret is, of course, one that is too low, causing the string to note one fret higher. This is most often found on less expensive, off-the-wall guitars. It's usually caused by a fret that was somehow driven into the fingerboard too hard or by a mismatch of fretwire height. These frets should be pulled up to the proper height, or new frets should be installed. I'm not trying to drum up business for the Guild of American Luthiers, but once again, take it to your repairman until you've had some practice. This can be another instant repair, so take care of it before you attempt any leveling.

Jagged fret ends along the fingerboard edge are uncomfortable because they catch your hand as you slide up or down the neck. They are usually caused by the fretboard drying out and shrinking up over time. You may use the flat-leveling file to rebevel the fret ends if needed, and the triangular crowning file can be used to round and deburr any jagged fret ends. Due to wear or an imperfect fret job, some frets fall short of the fingerboard edge or have jagged ends (above). Don't try to bevel all of the ends to match these; either have the troublesome frets replaced or do your best to deburr the ends and make them feel comfortable until the guitar's refretted.

Fretwire types and sizes

A customer with an old Les Paul "fretless wonder" asks, "Am I really missing anything by using a guitar with short frets?" Another wonders, "Will tall frets cause poor intonation?" The answers depend on the feel that you like and the sound that you want. In the uncomplicated old days, most acoustic and electric guitars came with little variety in fret styles; but today dozens of different fretwires—thin or fat, short or tall, soft or hard—are used for guitars. Generally, a thin wire is used for most acoustics, while a wide, or "jumbo," wire is common for electrics. I like the medium height wires better in either case because you can dress them more times between refrets. They also offer a better sustained note, are easier to bend on, and level and dress easier than low frets. Let's see what's available in fretwire so that you can better choose your new guitar or your future refretting job.

Fretwire is available in three shapes: rounded, squared, and triangular. The most

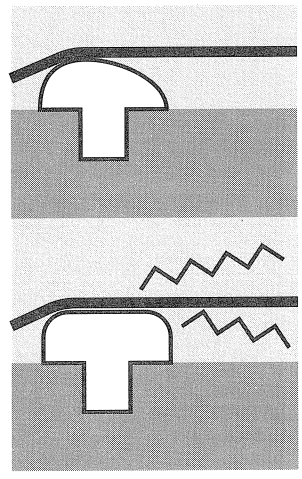
common fret shape, or profile, is the rounded head or "bead." You may have seen square and extremely low fretwire on a Gibson Les Paul or early SG. These guitars were nicknamed "fretless wonders," which they nearly were. This fret offered very low action with little drag on the fingers when moving up and down the board; sustain, tone, and easy bends were traded off for that action, however. Round- or "oval"-type wires (which have different heights, widths, and advantages) are far and away the most common, and therefore the most deserving of our attention here. As for triangle-shaped fretwire, you don't see it often, but it does exist. East coast luthier Phil Petillo manufactures, and uses, a hardened triangluar wire, but it's not readily available and hasn't been used much (if at all) on production instruments.

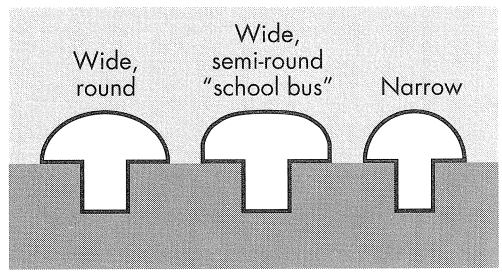
Tall fretwire ranges from .050" to .065" in height above the fingerboard (about the thickness of a dime). Not many tall wires are available. Here are some advantages: Tall frets are easier for string bends, since the fingertip has less contact with the fingerboard. They also offer more sustain, due to the greater mass and because the string isn't damped by as much finger/fingerboard contact, which draws away some tone, volume, and sustain. While tall frets don't offer the same advantages as the radical scalloped fingerboards described later in this chapter, they lean in that direction more than a short fret does, so you'll get better hammer-ons and pull-offs. They also outlast low frets and withstand more fret dressings between refrets. Some disadvantages: Poor intonation could result from pressing too hard, but this can be corrected with a gentler touch. Until the left hand relaxes, the frets may feel like railroad ties when you slide up or down the fingerboard, and the neck may "feel" slightly thicker, but this is minor.

Regardless of width, medium-height fretwire is the standard that has commonly been used for the last 40 years. Some very wide, medium-height wires are called "jumbo," but this refers to the width, not the height. This wire ranges from .036" to .050" in height. Pros: With jumbo frets, the player can more easily achieve accurate intonation (again, this depends on touch), since the fingerboard wood stops the fingertip, not allowing the string to be pressed too deeply. Barre chords and slides are easier, and the guitar's tone is softer, since the finger has more contact with the fingerboard. Cons: To enjoy medium-height fretwire at its best, the fret work must be done accurately, to ensure that you don't lose precious height during dressing. Medium-height wire wears out sooner than tall wire, and it allows fewer dressings between refrets. You'll still get years of playing out of medium wire if the fret work is good to begin with. Hammer-ons, pull-offs, bends, and sustain are not as easy as on tall wire, but most of us have been playing on medium wire for years and enjoying it; it's my favorite.

Except for the squared, low fretwire on the "fretless wonders," you probably won't run into low wire (.020" to .034") on a modern instrument. Expect to find low wire on used guitars that have seen much use and are simply worn out from years of playing and fret dressings. They're ready for a refret. While low wire is good for easy slides and fast action, it's not conducive to hammer-ons, pull-offs, string bending, and good tone and sustain. I do not enjoy playing on low wire.

A fret's width, regardless of height, affects playability and tone. Here you'll have to decide what you like. The increased mass of a wide fret offers a more "heavy metal" sustain than a narrow fret of comparable height, and wide frets wear longer than narrow ones. However, wide frets must be dressed more accurately than narrow ones to avoid poor intonation and buzzing caused by the string making contact off center (right), causing poor intonation, or flopping on a too-wide flat. Note: I dress a wide fret in two ways: rounded accurately to center, or semi-round like the top of a school bus (below). The "school busing,"

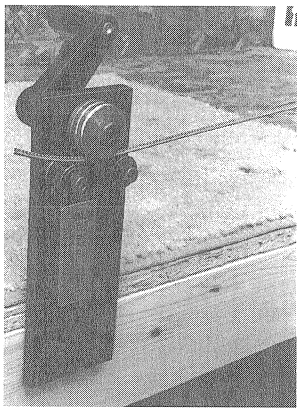




Don't run out and buy any tools until you've read this entire chapter—there are too many choices. Get what suits the job at hand.

which is often preferred by my rock customers, wears longer. Narrow frets offer a unique sustain, due to a cleaner contact point between string and fret crown, as well as the most accurate intonation. They don't have any disadvantages that I can think of, except that thinner frets have a crisper sound—clean, like breaking a glass—due to the accurate contact made between string and fret. This clean sound is sometimes misinterpreted as buzzing, and may take getting used to. The choice of fret width can only be decided by you. I prefer a somewhat narrow fret.

Fretwire hardness


The FretBender

A fret's hardness is determined by its composition. Usually the choice is 18% nickel/silver (hard), or 12% (soft). Stick with the hardest wire you're offered—it wears longer. Some classical builders prefer the softer 12% wire, though, feeling that it is more gentle on nylon or gut strings. The most commonly used fretwire for steel-string acoustic or electric guitars is 18% nickel/silver. Harder wire produces more sustain, but a greater advantage is its resistance to string wear. In most cases, the harder wire is the preferred choice (although, from a repairperson's standpoint, soft wire is easier to hammer in, and having less spring tends to "stay down" better than harder wire).

Relative fretwire hardness is a source of controversy in the guitar repair business. I've heard repairmen complain about customer remarks such as: "My guitar was refretted just a year ago, and the frets are grooved already." "My friend's '61 Strat has original frets that still play okay, with few worn spots. Are you guys selling us soft frets so you can get more work out of us?" Believe me, luthiers don't want their customers back in a year complaining of worn frets or expecting free remedies—fret jobs just ain't that much fun!

I checked with the fret manufacturers and found that they haven't changed their alloy specifications (as some of us have wondered). In the U.S., a 12% wire is considered soft wire, while the industry standard, 18% wire, is comparatively hard. The percentage—12% or 18%—refers to the amount of nickel in a given wire, not silver (fretwire *looks* silver, but it's made of copper, nickel, and zinc—with no silver at all). The alloy mix for an 18% wire is 65% copper, 18% nickel, and 17% zinc.

Fretwire is still made as it always was. It begins as a semi-hard round wire that is heated to anneal (soften) it, and it's then allowed to cool. It becomes "work-hardened" from being drawn through roller dies that compress the wire into a shaped fret. Once drawn, there's no practical way, at the manufacturing end, to increase fret hardness (in experiments, manufacturers found that rolling a too-hard wire, or wire with a nickel content over 18%, caused breakdowns in the machinery).

I sent old fret samples (saved over the years from vintage guitars), along with new ones, to a lab for the Vickers hardness test for precious metals. The results ranged from 184 to 205 points on the Vickers scale, with the modern wire being hardest in each case. The tests showed that large wire was harder than small wire. In the process, I began thinking about how hard copper gets when bent and unbent (those who have run copper water lines know what I mean) and ended up making what, for me, is a significant discovery. By running the fretwire through a Fret-Bender, over-radiusing it, and then straightening it and rolling it again (repeating the process several times), the fret hardness gained from 14 to 20 points on the Vickers scale, which is appreciable. I was able to work-harden a smaller, Strat-size wire until the hardness matched that of the jumbo wires used in the lab test! Tell your repair-man about this technique if he doesn't know it already.

If modern fretwire seems to wear faster than "vintage" wire, it's because modern players are more aggressive than those in the '50s and '60s, utilizing considerable single-note playing, string bending, and a heavier attack, all of which cause more fret wear. Today's harder string windings tend to wear frets faster, too. Also, many of the vintage guitars with original frets "still in good shape" were played with flat-wound strings—which aren't as hard on

frets, perhaps accounting for some of the perception that frets aren't what they used to be. The real key to fret wear is playing time. It doesn't matter how old a guitar is; what's important is how much it gets played. Leave it in the case, and the frets will never wear out! Today's guitarists, though, play and practice more than ever.

This basic information should help you understand the different types of frets. If you're shopping for a new guitar, ask the salesman to explain what size, and type, of fretwire has been used. Or if you're looking for a refret, see to it that your repairman uses a hard wire; it lasts longer (a soft wire is fine for classical guitars, though, since the nylon strings won't wear grooves as easily). Here are some of my favorite fretwires:

- Standard wide frets (vintage "wide oval" Gibson): Dunlop #6130 and Stewart-MacDonald #149 (.103" wide x .041" tall).
- Extra-tall and wide (modern heavy-metal wire): Dunlop #6100 and Stew-Mac #150 (.110" wide x .055" tall).
- Thin wires for electric or acoustic guitars (vintage Fender, Gibson, and Martin): Stew-Mac #148 and Dunlop #6230 (.085" wide x .041" tall).
- Medium width and medium height (Fender 'Stevie-Ray' size): Stew-Mac # 141 (.095" wide x .045" tall).
- Big Medium width and height (new size): Stew-Mac # 3391 (.092" x .048").
- Vintage Martin wire: C.F. Martin & Co: All sizes, including bar-style. (See "Compression-Fretting" for details on sizes.)

If you're serious about fret work, you should buy samples of any wire that arouses your curiosity, and check it out for yourself.

Files used for fret dressing

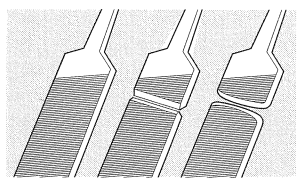
Before getting into fret dressing, let's first look at the specialized files which are used by most repairshops: the "leveling" files which are initially used to "mill" the fret tops flat and level with each other; and the rounding, or "crowning," files that reshape the fret tops after leveling. Most of these tools are available ready-made, or you can make many of them yourself.

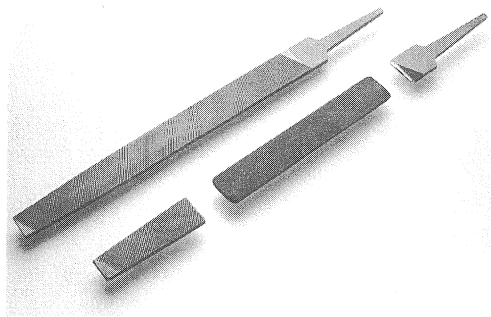
If money's not tight, buy fret files from a guitar shop supplier and avoid screwing up good files on your own. Getting a good grind's not easy.

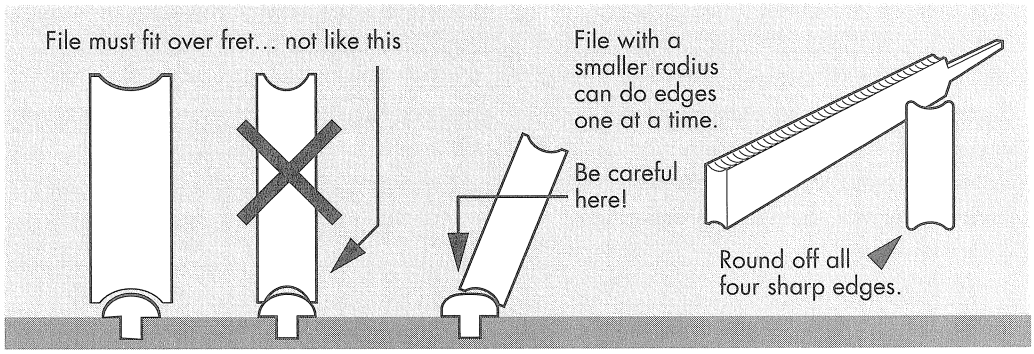
Some of the tools needed for fret dressing you can make yourself. At the hardware store, buy two 10" smooth-mill bastard files (choose ones that aren't warped), a 6" or 7" smooth-cut triangle file, and a "file-card" (a wire file-cleaning brush). Modify the files using my illustrations as a guideline. Caution: Unless you own a grinder with a good stone wheel, and are familiar with the necessary operational safety precautions, have your files ground at a machine, welding, or grinding shop. This is simple for them and inexpensive and safe for you. If there's a high school or trade school nearby, ask the metal-shop teacher if a student needs a small project. Your files can probably be ground while you wait. Note: Few people realize that grinders are dangerous—even those little ones everyone has in the garage. The danger lies in stone wheels that are cracked or otherwise in bad shape. If these come apart while under speed, the exploding fragments could kill you or maul your face. This happened to a friend of mine; he's okay, but only because his father, a surgeon, happened to be home at the time. Don't get me wrong, I use grinders—but only with approved full-face protection, and I'm very cautious. Please do the same.

LEVELING FILES

One of the 10" files should be cut into two lengths, approximately 3" and 6" long. These are the leveling files that will be used to rectify high or low frets and hump or rise, as well as to create fall-away at the high end of the fingerboard. To cut the file into the two lengths, you must grind a V-shaped groove







on opposite sides until the cuts begin to meet in the middle.

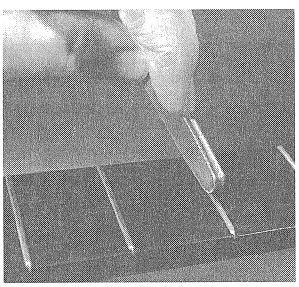
Then, with the file clamped to a tabletop or in a vise, break it along the scored line. Grind the broken ends into a smooth, rounded shape. *Always wear safety glasses when grinding and breaking!* You now have two leveling files—a short and a mid-sized one. The 3" one is for leveling one or two problem frets (especially those on the section of the fingerboard that overlaps the guitar's body), and the 6" one is good for mid-size sections of the fretboard (it's also great for smoothing the fret end bevel along the fretboard edge—especially after a refret).

Finally, with the longer 10" (uncut) file, simply remove the "tang" (handle) and the untoothed metal at each end of the file, and then round and smooth the sharp edges. You'll end up with around 9" of good usuable file—this is the basic leveling file used for general smoothing of the whole fingerboard.

With epoxy or super glue, install wooden handles onto all your files.

ROUNDING FILES

These you can't make yourself. They come in several sizes (to accomodate frets of different width) and have teeth which are formed into a convex shape. It's best if a rounding file is larger than the fret size so that it fits easily over the fret crown. A file much smaller than the fret width can cut grooves into the sides. Some files have both a narrow and a wide groove—on opposite edges. Others have the same size groove on both edges. Over the years, I've purchased every fret file there is: call me compulsive, I don't mind.


Diamond rounding file

A rounding file sits over the fret, but the radius of its teeth isn't deep enough to allow the file edges to touch or scratch the fingerboard wood; this could happen with an extremely worn or low-crown fret, however. Sometimes it's effective to use a rounding file with a radius that's smaller than the fret width for rounding just one edge of a flat-topped fret on either side of center, but you must be careful that the edge doesn't cut a groove into the fret top by mistake. These edges of the file where the teeth run into the smooth side walls are often sharp; grind or sand them smooth along the entire file length to avoid gouging the fingerboard on each side of the fret as you're working.

The *type* of cut imparted by a rounding file is round, of course. The file's function is to round off, or "recrown," frets that are filed or sanded flat during the operation of fret dressing or leveling. The *quality* of cut depends on the make of file and how it's used. New files tend to chatter and leave hard-to-remove marks on frets. Here are a few tips for fret rounders: Avoid excess pressure with rounding files. Clogged metal in the teeth causes scratching, so clean them often. Wipe a stick of paraffin over the teeth to act as a lubricant and help eliminate clogging. Practice on scrap to check the cut of a new file.

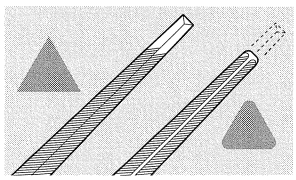
DIAMOND ROUNDING FILE

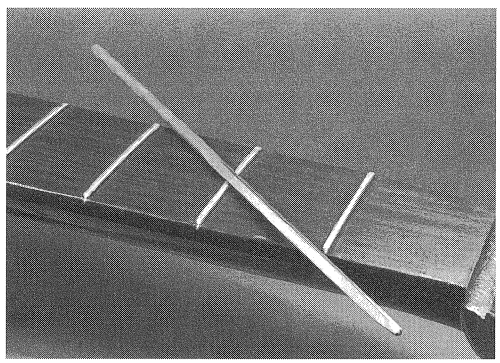
These are my favorite. Rather than having teeth, the convex surface is covered with industrial diamonds. These files (coarse and fine grits are available) don't leave scratches that you can't get out, and they cut in both directions! Even dyed-in-the-wool "triangle filers" love this file once they give it a chance. I seldom use toothed files anymore.

TRIANGLE OR 3-SQUARE FILE

Another great fret-dressing tool is a 6" to 8" slim-taper, three-corner "triangle" file with its sharp edges ground smooth. I learned to use one during my visits to the Gibson plant in Kalamazoo in the good old days. At the time, I had a beautiful flame-top Les Paul, and because I never trusted myself to work on it, the frets were dressed more than once at the factory. (In those days, you could make an appointment to have service done while you waited. I learned a lot by wandering around and watching.)

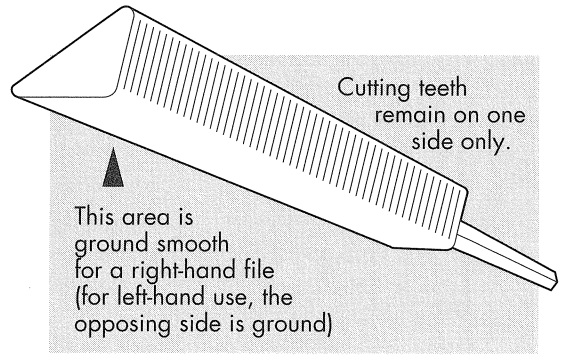
The triangle file can be used instead of, or along *with* a rounding file to round or crown the fret tops left flat after the leveling operation. It is also used to round over the frets' ends and remove any jagged burrs along the fingerboard's edge. You must remove any trace of a cutting edge on all three corners of the file with a grinder or belt sander (here's a look at the file before and after). Also, blunt and round the tip, or nose, of the file. A poorly ground triangle file can scar the fingerboard wood on either side of the fret you're working on, even though you have taped off the fingerboard.





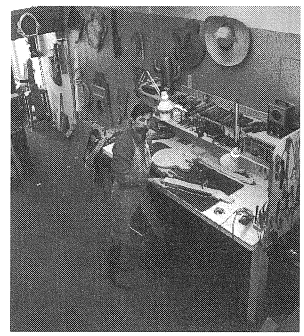
A second triangle file is the small extra-slim triangle file from Stew-Mac. Unless I'm "hogging" metal, I prefer this file because it has a finer cut, is more delicate, and can shape fret ends better since it can get in closer .

When you shop for your files, pick up one sheet each of wet-or-dry sandpaper in 320-, 400-, and 600-grits, as well as some 0000 steel wool and a file-cleaning brush (also known as a file card). My favorite file card has small metal bristles on one side and fiber bristles on the other; buy one if you can find it. Even better than a file card is a brass-bristle mini-file cleaner;they're great for cleaning small, fine-cut triangle files.



CANT SAW FILE

A third file—the cant saw file—is used out in Texas by Michael Stevens and Rene Martinez. Michael Stevens co-founded the Fender Custom Shop along with John Page, and now operates Stevens Electrical Instruments in Alpine, Texas; Rene Martinez was Stevie Ray Vaughan's guitar tech and best friend (see section on Stevie Ray's setup). The cant saw file is similar in cut to the large triangle file, but cuts even faster. These are also available at hardware stores and should be ground to look like the illustration. When the fingerboard is taped off, you can rest the smooth-ground edge of this file directly on the fretboard surface for support (you don't have to balance on the fret as with other files). Because the edge facing down on the fretboard is ground smooth, this file only cuts from one side of the fret to center, so the guitar is turned end-for-end to do the opposite side (which most of us do anyway to get the fret ends). Stevens has both "right"- and "left"-hand files (the file in the drawing above is a right-hand file).


Michael Stevens

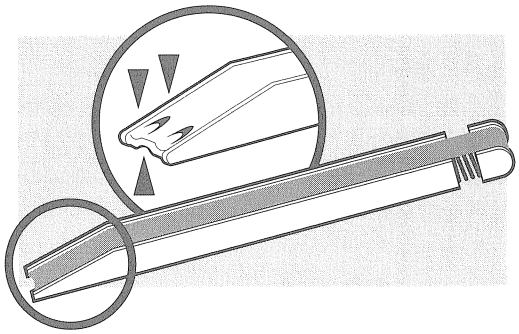
I've been criticized for having too many files for fretwork, but I don't care. *Not* having a wide selection of files is rather limiting (especially if you're in the business of working on frets). I often have quite a selection of specialty files laid out as I work.

SANDING TOOLS

A good tool for sanding and steel-wooling frets after leveling and rounding is a rubber squeegee from the 3M Company. This should

Blues-bend buzzing ceases to be a problem with a radius of 9½" and up. This radius, introduced by Fender in recent years, is a good compromise between the curved board of vintage Strats and the modern 10" and 12" fingerboards.

be available at any automotive store selling finish supplies. Buy the smallest rubber squeegee available, and grind or file a groove along one edge of it. Eventually, you'll wrap the steel wool or sandpaper around the edge of this "fret burnisher" to do your polishing (look at the section on fingerboard cleaning for an illustration of how to shape the squeegee).



An even better fret burnisher is the "Sand-Stick"—an inexpensive hand held sander with a spring-loaded abrasive belt. I file three slight grooves into the plastic—two on one side and one on the other [ILLU was in trade secret]—which hug the fret's rounded shape. I use three "Sand-Sticks" during dressing: 320-, 400-, and 600-grit.

Finally, pick up a roll of masking tape for taping off the frets while you file and sand them. You should have the light-tack drafting tape as well as standard masking tape.

It will take you a little time to find and modify the proper files and to buy the sandpaper, steel wool, and squeegee. Again, finish this whole chapter before starting work!

Dressing the frets

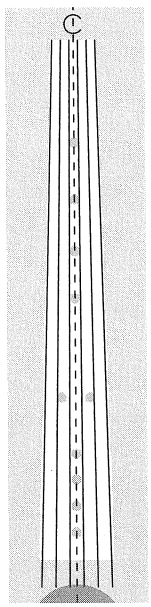
Now, we're about to put this knowledge to use, BUT—first read the following section on compound and cylindrical shaped fretboards, then you can pick up your file!

THE COMPOUND RADIUS VS. THE CYLINDER RADIUS

Understanding the difference between a cylinder- and a cone-shaped, or "compound," fretboard may be the most subtle—and important—fretting task you'll face. The ability to use this knowledge during fret dressing or re-fretting separates the novice from the professional, and the clean playing note from a buzz—yet I've never seen it explained!

In my opinion, radiused fretboards are more comfortable for playing chords than are flat fretboards because they follow the natural curve of the hand. A player choosing a guitar should have the fretboard radius in mind. The most heavily-radiused fretboards are Rickenbacker and Fender, but for some reason we always refer to Fender when describing the problems associated with low action and a radiused fretboard—like the vintage Fender 7¼" radius. This radius is very comfortable to chord on, but when you bend the high-*E* string (and to a lesser degree the *B*) the string will often "note out". The solution is to raise the strings higher (which doesn't please most players), or come to grips with the compound radius. If you're a player who never bends strings, or doesn't bend very far, then even a vintage Strat or Tele with a 7 ¼" radius can have a fairly low action without buzz, and you needn't mess with compound fretwork at all.

A flatter fretboard radius offers fewer problems to string benders. Gibson's traditional 12" radius has always been good for blues-bending, and Martin's 16", too. But the flatter you get the radius, the less chord-comfort you have. So an "in-between" radius like a 9" or 10" may be just right. For some, a combination of radii—the compound radius—is the answer.



Most fretboards are radiused (they have a side-to-side arc). A machine cutter creates a perfect cylindrically shaped radius the length of the board. When the fingerboard gets "profiled," or cut to the tapered width of the neck (viewed from above), the fingerboard is much narrower at the nut than at the very last fret. Looking down from above, notice that the outer two *E* strings follow the taper (profile) of the fingerboard—they're not parallel to the fingerboard's length (or center line). The

remaining four strings follow the same taper but gradually become more parallel to the center line, with the space between the *D* and *G* strings being on dead-center.

Imagine this profiled cylinder-shaped fretboard glued to a neck adjusted perfectly straight. A straightedge set on the board in the lie of the strings (the individual string's line between the nut and saddle), especially the outside *E* strings, will rock from end to end because the *only way a straight line can be in full contact with the surface of a cylinder is when it is parallel to the center.* Take a cylinder—a water glass—and set your straightedge in full contact with the glass' surface lengthwise—from end to end. As soon as you slant the straightedge to the centerline (out of parallel) it loses contact from end to end and rocks on the "hill" in the center.

A fret surface which was machine-radiused at Fender in 1957 was not touched before being fretted. The board—and the fret tops—are a cylinder. The string, following the profile (or being at an angle to the cylinder's centerline) is going to "rock" in the center on the high spot (like the water glass)—especially when the high *E* or *B* is pushed at an even greater angle (out of parallel) to the centerline during string bends. This is why Fender began offering a 9" and 12" radius (only keeping the 7¼" radius on the vintage models).

The only way to avoid this rocking in the center is to shape the fretboard (or the water glass) into a cone. A cone-shaped fretboard simply means that the radius at the nut will be greater than at the last fret—the fingerboard radius will flatten gradually from end to end. In repairshops we have been compounding fretboards for years (when applicable) to give customers low action with blues-bending capabilites and little buzz. Some manufacturers who use, or have used, a compound radius are: Warmoth, Jackson, Collings, Taylor, and Martin.

When preparing the fretboard for a fret job you will sand, file, or scrape the surface until it's straight from end to end across the radius of the board. Note: *If you check your progress with a straightedge resting in the six individual string lies (which is the most common method), you are shaping a slight compound taper into the fretboard.* In the case of a refret on many factory guitars (Fender, Gibson, Guild, Martin after '93), you're altering the machine-made cylinder which was never intended to have a taper or "profile."

Vintage Martins were compounded this way. They started out with a 16" machine-shaped clylinder fretboard which became tapered to 20" at the end because Martin hand-levelled the board in "the lie of the strings." Martin guitars made after 1993 have cylindrical fretboards with no taper because they changed their fretboard preparation technique (they realized that for a 16" or higher radius, a compound fretboard wasn't too great an issue, especially on an acoustic guitar). As a general rule, the radius of an average compound fingerboard flattens out about 3" or 4" toward the end of the fingerboard.

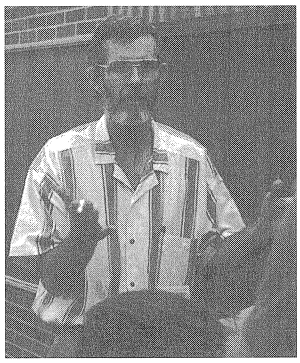
Many of the vintage 7¼" Fenders have no buzz problem because they're broken in from years of playing.

A QUICK FIX FOR A VINTAGE BUZZ

The quickest fix (although I'm not suggesting it necessarily) for vintage Fenders which buzz when you bend, is to relevel the existing frets until the straightedge sits flat on the top three string lies (the *E*, *B*, and *G*-string lies). You don't need to worry about the bass side because the strings are heavier, higher, and you don't bend them much. You'll be removing the most metal on the edges (*E* and *B* strings) where the string taper is greatest. The first and last few frets will hardly get filed at all because they aren't part of the "hill" which is causing the problem. You're creating a slight compound radius on the fret tops themselves.

After compounding, some frets will be taller than others, but if the frets were fairly tall to begin with the lowest ones usually aren't uncomfortably low. Coupled with the traditionally higher action normally accepted with a vintage Strat, you can now get the blues bends you're after. This solution is only worthwhile on a vintage axe which still has plenty of fret to work with, however, and that's not too common.

A better solution is to put the compound radius into the fretboard itself—prep the board's *surface* that way. Now the tops of the newly installed frets will touch the straightedge (after a normal light fret leveling) because the


Don MacRostie

frets will follow the compound radius from end to end (and the fret height will be uniform). This "compound leveling" is common during a refret, and I fretted guitars like that for years before realizing that what I was doing had a "name" (a compound radius). You can't compound a vintage maple neck without removing most (or all) of the finish however, and neither can you reshape thin "veneer" rosewood Fender boards (there's not enough wood to remove). In all cases—especially the most radiused boards, you have to take inlays and fingerboard side dots into consideration.

It's easy to run into side dots, especially on Fenders. Since Gibson starts out at 12" (sometimes) you have less chance of hitting side dots, but it's still possible. Because of side dots, inlays, and the fretboard thickness/look/feel, a "partial" compound job may be the answer. In other words, you don't go *all the way* (following the formula which is given later), but simply in the *direction* of a somewhat flatter board.

Knowing that I generally "read" and prep a fretboard with my straightedges resting on the lie of the string (creating a cone), I wanted to know what radius I should look for at the fretboard end, and—perhaps even more important to final setup—what is the projected radius when it meets the bridge saddle? I asked my good friend Don MacRostie—head of R&D at Stewart-MacDonald. Working with two other interested luthiers, Gila Eban and Dana Bourgeois, Don worked out three basic fingerboard radius formulas.

The purpose of these formulas is to keep us from removing more wood than necessary while attempting to get the straightedge to sit flat on the fretboard during a refret. The amount of wood to be removed is more subtle than some realize and is determined by the fingerboard's taper (width of the nut and 12th fret), scale length, and starting radius at the nut. With it you can find out what the radius must be at the end of the fingerboard, at any point along the fingerboard (for checking your accuracy with radius gauges as you work), and determine the projected radius at the bridge saddle. It's very useful information!

DON MACROSTIE'S "CONE HEAD" FORMULA: HOW TO DETERMINE A RADIUS AT ANY POINT ON A FRETBOARD

Memo

To: Dan *From: Don*

Dan: Here you are. Anyone doing a fret job who doesn't understand the difference between a cylinder and a cone is working "blind." If they understand it and choose to ignore it, that's a different story!

Straight lines that run lengthwise on a cylinder and are in full contact with its surface must be parallel, and could never be tapered to each other as guitar strings on a fingerboard are. I have drawn out three formulas for dealing with the phenomenon of string spread over a curved surface. Whenever straight lines eventually converge on a point (the fingerboard tapering from the body toward the nut), and those straight lines lie in full contact with a radiused surface, then the shape of that surface must be conical or some portion of a cone. First we must determine where the lines (strings) converge. I've defined the following:

X = Distance from the nut to the Origin (focal point)
T = Distance from the nut to the 12thfret
Sn = String spread at the nut
St = String spread at the 12th fret
Rn = Fingerboard radius at the nut
Rd = Fingerboard radius at "D" (a certain distance from nut)
D = Arbitrary distance from nut

1 Using the spacing of the two *E* strings at the nut and 12th fret, extend the lines until they converge (illustrated at top of next page). Measure from the point of convergence to the nut and you will have "X" or the focal length. X is then used in the remaining formulas. The formula is marked #1:

1

$$X = \frac{T}{\left(\frac{St}{Sn}\right)^{-1}}$$

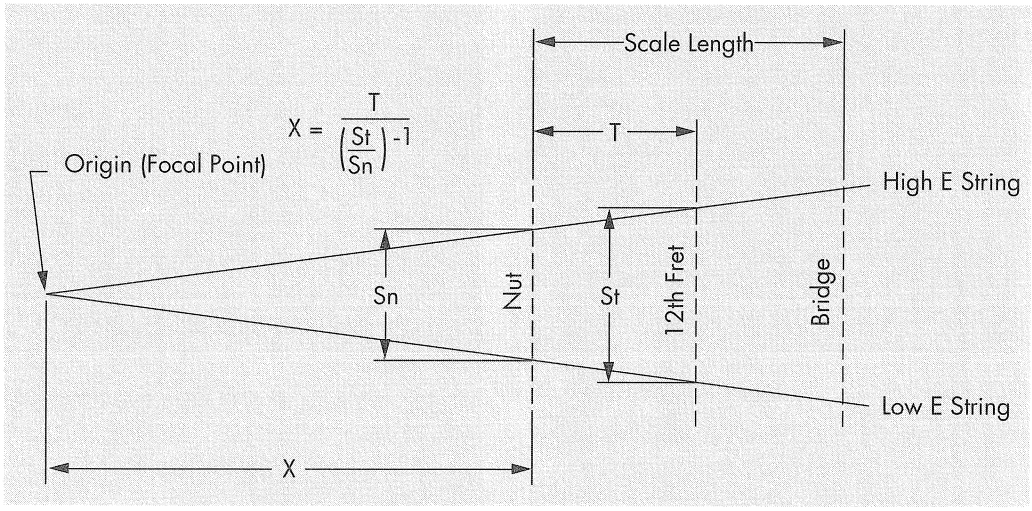
2

$$Rd = \frac{Rn\ (X + D)}{X}$$

3

$$D = \left(\frac{Rd \times X}{Rn}\right) - X$$

2 The second formula (see #2 above and illustration following) assumes that you have



already determined (X), the location of the Origin of the cone. This solves for the radius at any point along the fingerboard represented by the value D.

3 The third formula, to find the point D where the radius equals a known value, is written as #3, at left. This formula can be rearranged to solve for any of the values.

All of these formulas are linear and relatively easy to solve and rearrange.

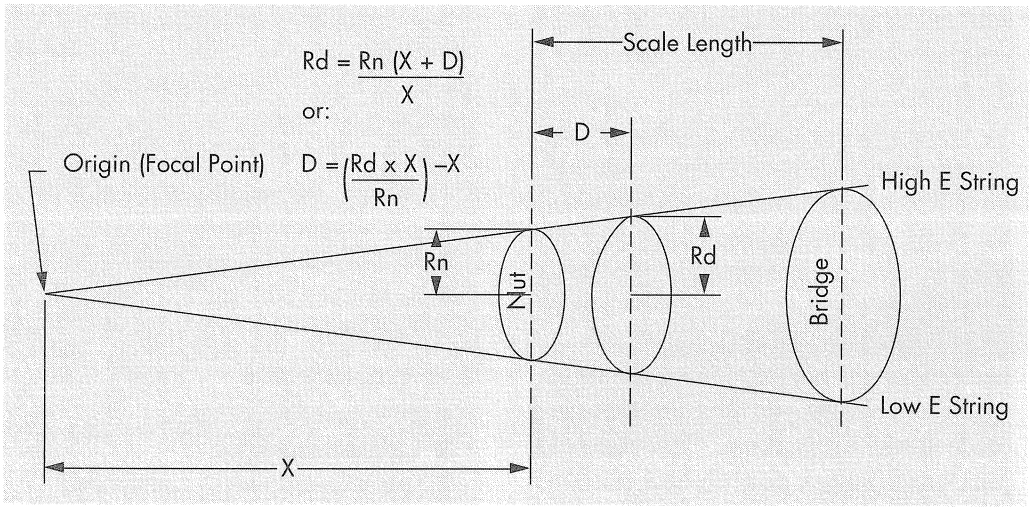
Note: When we were done we discovered that we'd just "rediscovered the wheel." Two similar formulas, overlooked by us, were published in the GAL's *American Lutherie* magazine: "In Search Of The Perfect Cone" written by Tim Earls—Vol. 30 (summer '92, page 44); and "Conical Radius Fretboard Formula" by Elaine Hartstein—Vol. 34 (summer 93, page 46) Check your back issues, or contact the GAL for those articles.

GETTING TO WORK

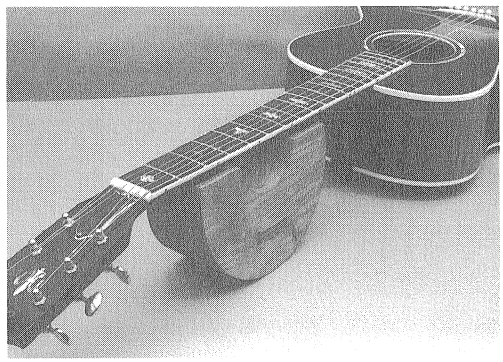
OK. Enough theory. First check the fretboard radius; if it measures the same at the nut as at the last fret, you have a cylinder-shaped board (*a la* Fender and Gibson). If the radius is flatter at the last fret than it is at the nut, then you have a "compound," "cone-shaped,"or "tapered-radius" fretboard. Below are two ways of leveling the fret tops with a file: one for a cylinder-board, and one for a compound. Using either method, the file stroke is always lengthwise with the fingerboard. Until you gain experience at fret dressing, practice on yardsale specials.

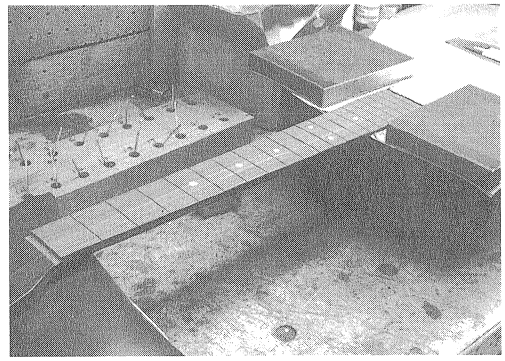
THE LEVELING POSITION

Using the neck evaluation and truss rod adjustment section of the Getting Started chapter as a guide, adjust your truss rod to remove any relief. Get the neck straight from the 1st fret to the 12th, using a metal straight-



Until you gain experience, practice fret dressing on yardsale specials.





edge for comparison. Then duplicate this straight, or "leveling," position with the strings removed. Lay a towel or pad on the table top, covering it and the entire work surface with newspaper to catch any metal filings. Rest the guitar's body on the padded part of the work surface, and cradle the back of the neck on a stack of books or anything else that can serve as a support. (I like the "canteloupe" neck rest used by repairman Pete Towers in Chesterton, Cambridge, UK. It's fantastic!)

Any neck support should be padded, and covered with paper as well, because filings will scratch the lacquer on the back of the neck. (To avoid scratching, vacuum or remove the filings often). Check with your straightedge again to be sure that the neck support hasn't altered your neck straightness. If it has, move the support to a different part of the neck and/or make a slight truss rod adjustment.

Note: Even with the strings removed and the truss rod loose, some necks may tend to back-bow slightly. These necks gain relief from string tension alone. In this case, support the headstock, not the back of the neck, and later you may either put slight pressure on the body or pull down on the neck's heel to straighten the neck as you file.

A better way than pulling down on the heel to get the neck into the "playing," or straight, position was shown to me by Rich Starkey at the Martin repair department. For simulating string tension on a neck—whether refretting or dressing—Rich supports the peghead and then sets two 6 lb. weights on either side of the fretboard on the shoulders of the guitar (above, right). For a non-flat-top (like a Les Paul), use a sandbag or sack of buckshot. The weights add just enough pressure to get the neck of a non-adjustable Martin (or any guitar) into the perfect leveling position.

TOOLS USED FOR DRESSING FRETS

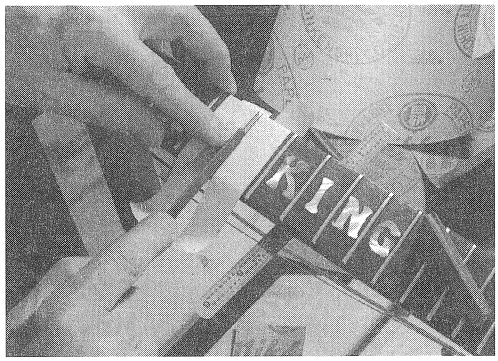
Here are two lists of the tools used to level and crown (round) the frets. Listed here you'll see the files that were just described. One list is for the beginner, and shows the minimum number of tools needed to "get by"—what you *must* have; the other list describes the tools that *I* get out for "fret dressing." I won't get out all the listed tools if I've just refretted the guitar in question—I know my fretting job was accurate, so I'll only need to kiss the fret tops and polish them. During a regular dressing, however (on someone *else's* fretwork), I get a good number of files out.

"MUST HAVE" TOOL LIST

- Straightedges—whatever you use—at least a long one for checking general levelness, and a couple of short ones to test individual frets by "rocking" on a high spot (any short flat object can be used as a "straightedge" in a pinch).
- 10" leveling file, or substitute a 2" x 8" carborundum stone (whetstone)
- 1 rounding file (diamond, triangle, cant saw, Gurian, etc.)
- 1" wide x 14" long sanding block
- 320-, 400-, 600-grit wet-or-dry sandpaper (self-stick, or use double-stick tape). The 320-grit is for leveling, the other two are for polishing out marks after filing.
- Mini-file cleaning brush—brass bristle
- 0000 steel wool
- Masking tape

THE TOOLS I USE

- 3", 6", and 10" leveling files
- Carborundum stone
- Steel leveling block (for sandpaper)



- 220-, 320-, 400-, 600-grit wet-or-dry sandpaper (preferably Gold self-stick)
- Small and large triangle files
- Cant saw file
- Coarse-grit and fine-grit diamond rounding files
- Mini-file cleaning brush—brass bristle
- Three "Sand-Sticks"—with 320-, 400-, and 600- grit belts
- 0000-steel wool
- Draftsman's tape, masking tape, and "Flatback" heavy-duty binding tape
- Small flat file (Stew-Mac Fender nut-seating file #1174 (for removing burr and cleaning up individual fret ends)
- Straightedges—long, short, notched, and a set of fret "rockers" in 1½", 3" , 4", and 5" lengths

USE PROTECTION AT ALL TIMES

With masking tape, protect any part of the guitar that can be scratched by your files or sandpaper, especially around the fingerboard tongue and the pickups (which, if not protected, will magnetically attract and retain metal filings and steel wool dust). To insure that the tape won't pull off delicate vintage finishes when it's removed, I lay down one course of the less-sticky drafting tape directly on the finish, and then, with regular masking tape, I tape thin (.018") pickguard material onto it as a protector.

REMOVE THE NUT

In theory, the leveling file must pass over the nut slot if the file is to hit all the frets equally. In practice, you can stop your file stroke at the nut as soon as the tops of all the frets have been hit. If the nut can be removed and replaced easily, or has to come out anyhow for replacement, *and* if vintage isn't an issue, remove it—you'll level the frets more effectively. First, carefully score around the nut with a sharp X-acto knife to break the lacquer. With a block of wood and a hammer, gently tap the nut to knock it loose, as described in the Nut Work section.

HIGHLIGHT THE FRET TOPS

I use blue Magic Marker to "blue" the fret tops before filing. This lets me see instantly what's being removed and is especially necessary if you're doing the tricky "sideways" leveling mentioned later.

Since the file is flat, a number of successive passes are needed in order to cover a *radiused* frets's width. The blue magic marker helps you see how much fret the file is contacting on each stroke. The straightedge must be able to rest flat on all the fret tops (except for a slight fall away of .002" to .004") when the neck is in the straight "filing" position. Note: The posi-tion in which you place the straightedge on the frets depends on whether the fretboard you are leveling is a cylinder or a cone!

Caution: Tape off the fretboard to avoid getting marker on the wood—especially on binding, light rosewood, or maple necks! In fact, you probably shouldn't use marker on a maple neck!

GET RID OF ANY HUMP AT THE BODY JOINT

First, check out the fretboard extension: Many necks straighten easily with a truss rod adjustment and have no hump or rise at the neck/body joint or out on the "tongue" (fretboard extension over the body); with these "good" necks, you really won't have to do much filing—you'll only be "kissing" the tops. However, if you have a hump, rise, or high frets on the tongue, *level those frets first* so that they don't cause the straightedge to rise up while you're checking for flatness on the main portion of the board.

To remove a hump or rise, use the short leveling file to work down any small, isolated problem frets. Check your progress constantly—a small amount of filing can make a lot of difference. Note: Many necks are not set at an exact 90° angle to the body, and a straightedge resting on the main fingerboard

Several new fret-dressing tools have become available since 1985 when I started writing for Guitar Player. At Stewart-MacDonald I designed a long and short fret-leveling file with wooden handles and very smooth, long-angled teeth; and also a miniature, super-fine, three-cornered (triangle) file. Another tool, the Sand-Stick, is a small, plastic, spring-loaded belt sander used for sanding the fret tops after they've been crowned with the triangle file.

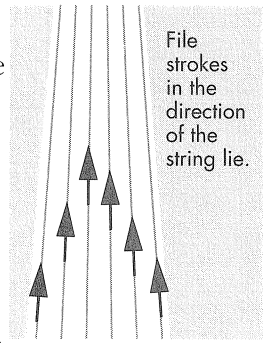
from the 1st fret to the neck/body joint may be on a different plane from the tongue, with the tongue naturally falling away because of this angle. This is normal, and should not be confused with a "hump," which is actually due to a swollen glue joint or high, loose frets. Usually, the most annoying problem on the tongue is a rise, where the last few frets are higher than the ones preceding them. Sometimes this takes a fair amount of filing to rectify, and in extreme cases it will leave the last few frets quite low and hard to round.

When you feel that you've eliminated any high or low spots on the tongue, restring the guitar to pitch, readjust the truss rod accordingly, and check the relief and/or straightness, and fallaway as described in the neck evaluation section. Once any tongue problems have been eliminated, the straightedge will give you a much more accurate reading on the main fingerboard (1st through 12th frets).

LEVELING THE MAIN PORTION OF THE FRETBOARD

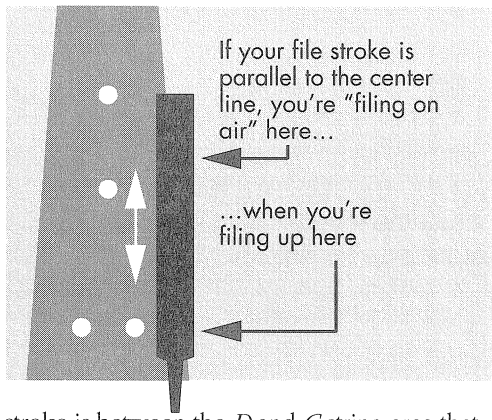
Use the longer (10") file—this file must be the flattest you can find! Your goal is to create an accurate, smooth plane across the tops of the frets, so that no fret is higher or lower than any other. You want to expose new metal, or a fresh "flat," on each fret. With the longer file, begin where the tongue filing ends and file in long, even strokes from the body towards the headstock, applying light pressure. Always file lengthwise with the fingerboard, and because a mill file only cuts in one direction (we use the forward (push) stroke), don't file "back and forth". In theory, the file stroke should continue right off the fingerboard at the peghead end (out into space) so that all the frets get filed the same amount. You don't always have to do this however, and if you do, be careful not to dip the file and hit the shafts of the tuning keys! I usually stop filing when my tool has passed about halfway over the 1st fret. Then I back up and make another pass, continuing in this fashion until I've covered the width of the fingerboard from end to end.

Many repairmen prefer to use a carborundum stone to level the fret tops—especially if the fretwork was well done and there isn't much metal to remove. The Martin repair shop, and the fretting department, recommend a Crystolon fine bench stone, #FJB8.



COMPOUND OR CYLINDER: TWO DIFFERENT APPROACHES

1 Compound—The file stroke should follow the 6 individual string lies created by the fretboard profile. Then smooth the flats together using the file in a sweeping arc across the fretboard, working lengthwise and across the board at the same time (do this from the treble side toward center, and then the bass side toward center). The only "straight" file



stroke is between the *D* and *G* string area that is perfectly straight, or parallel to the center.

2 Cylinder—The file always remains parallel to the centerline. If you start filing on center, part of the file will be "filing on air" as you approach the fretboard edge. If this feels uncomfortable, you can begin on the edge, going lengthwise, but moving the file sideways, toward center, *while* you're moving lengthwise. This is a tricky stroke, but it works great!

Cylinder-shaped boards can easily be compounded during a refret (sometimes by accident), depending upon which of the two methods listed above are used on the fretboard.

REMOVE THE LEVELING MARKS WITH SANDPAPER

After leveling with a file, I use 280- and 320-grit sandpaper to smooth the fret tops and remove the somewhat harsh file marks. Either wet-or-dry (black), or else the "Gold" metal-

In the C.F. Martin fretting department: Carl Frantz levelling with a bench stone.

cutting sandpaper works best for leveling frets. The "free-cut" (blueish gray) lacquer-sanding paper doesn't work as well on frets as it does on finishes or wood—it breaks down too quickly on metal.

For compound fretboards, my leveler is a steel block which measures 1¾" x 1" x 15". I use the 1" edge, which is ground perfectly flat and faced with self-stick paper. The weight of this chunk of steel makes for instant, controlled leveling, but a block of wood or plexiglas would work too if it's flat (the weight of the steel is nice, though).

On cylinder-shaped fretboards, I use radiused sanding blocks (with the same self-stick sandpaper) instead of the heavy flat block. *But they can only be used for sanding on cylinder-shaped boards!* If you level the frets in the compound manner, the radius blocks would just "erase" your work since they can only create a cylinder. Don't mix up the two methods of leveling!

Note: One or two passes lengthwise is maybe all you need for each sanding grit: don't overdo it. The wet-or-dry black and gold sandpaper cuts fret tops like butter. In fact, when the frets only need a light leveling, you can level the frets without files at all—using just sandpaper!

LEVELING WITHOUT FILES (USING ONLY SANDPAPER)

If the frets are in good shape and don't need heavy leveling, you can skip using files entirely and level the frets using just the flat block—or the radius blocks—and sandpaper. Whether you're filing or sanding, use different pressures if you need to blend one section (for example, the 1st through 10th) into another (the 10th through 15th). If you know there is a high fret or a cluster of them, use your 3" or 6" file to work down that area. Follow with the long file to feather it in. A beginner should string to pitch often and readjust the rod to see how the feathering-in affects relief, leveling out, and fallaway. You can always get the neck back into the filing position if—when you begin—you put a mark on the truss rod nut as an index and return to it every time. The approach just described for leveling compound and cylinder *fret tops* is also used to level the wood of a fret*board* during a refret, but with some different tools (files aren't always the best way to remove wood).

ANOTHER TIP FROM THE OLD WEST

Texas luthier Mike Stevens has this advice: "When all the level-filing and lengthwise sanding is done, I use a 5¾" x 2" wood block wrapped lengthwise with 320- or 400-grit sandpaper strips. Cut the sandpaper into strips less than the 2" width of the block, and long enough to wrap lengthwise on the block to stretch it tight—it doesn't sag that way. Go sideways (in the direction of the fret) with the sanding block to remove the final marks. From this point on, all your work will be in the direction that you bend strings—just to add that extra edge."

CLEANING UP THE FRET END BEVELS

Now, feel the fret ends. Sometimes they'll stick out beyond the fingerboard edge because the wood has shrunk while the metal fret hasn't. You can smooth the ends until they're flush with the wood by using the 6" leveling file held flat but lightly against the edge of the fingerboard. Avoid filing the finish any more than you must. If the fretboard edge is straight (you can sight it as if you were sighting levelness of the fretboard) the file will ride smoothly along the finish and cut only the fret ends. If the fretboard edge is irregular, use the 3" file; its shorter length lets it follow the contours. If you find it difficult to get the ends without damaging finish on the fretboard edge, use the small "touch-up" triangle file mentioned earlier.

If you start to remove finish, stop. Then lightly sand any dulled finish with 1000- to 2000-grit wet-or-dry sandpaper, using water as a lubricant, and return the original gloss by polishing with Mirror Glaze # 7 to finish the job.

Normally during a fret dressing, you won't have to do much *beveling* on the fret ends, since they were beveled during the original factory fret job. But while you're cleaning up the fret ends, hold the file at the angle of the bevel and kiss them too—being careful not to over-bevel them (you'd remove playing area)! Watch carefully until you see the file just touch the sharp edge of the fretboard and stop! I use a