MARKETPLACE

Photo by Ian Lindsay

Bruce Martin in his workshop

*Bruce Martin is a self-taught instrument repairman currently living in Calgary. Music and instruments have been a sustaining interest throughout his life and he has been a guitarist for over twenty years. In 1974, Bruce became interested in carpentry and was fortunate enough to apprentice to a master. Once having learned and perfected his woodworking skills, he became smitten with the desire to learn instrument repair and began collecting books and tools. "I began doodling around with my own guitars," he says, "and some old junkers at first. Soon friends were bringing their instruments for me to have a look at, and it just sort of grew from there." Bruce works alone in a small basement shop (Acoustic Guitar Workshop) taking in his own work as well as repairs for a local music store. This summer he began trying his hand at instrument building, turning out several dulcimers. He intends to move on to guitars in the near future. "*Everyone *asks if I've built a guitar yet; I'm going to have to do that just so I can say 'yes'. I certainly lucked into the right name for it, didn't I?"*

Aside from repair work, Bruce also teaches private beginner guitar lessons and small group classes in country flatpicking and bottleneck country blues, and appears from time to time at local coffeehouses. People wishing to get in touch with Bruce can do so at: Acoustic Guitar Workshop, 1201 Bowness Road NW, Calgary Alta. T2N3J6, tel. (403) 283-5786.

ACTION ADJUSTMENTS ON STEEL STRING GUITARS

GENERAL CONSIDERATIONS

Before any action adjustments can be carried out, the general condition of the instrument must be taken into account. Is the heel (where the neck joins the body) cracked or separated? Is the bridge lifting away from the top? Is the neck set at the proper angle to the body? Is the top pulled or bellied? Are there any cracked or unglued braces? If any of these conditions exist, they will have an effect on the playing action, and should be repaired prior to action set-up. On flat-top steel string guitars, the neck should be set at an angle such that the fingerboard at the nut is approximately 1/8th to 3/16ths of an inch above the plane of the top. This can be easily checked with a straightedge. If measurement falls outside of the above figures, the neck will likely need resetting to the proper angle.

Most flat-top guitars are, in actuality, not absolutely flat. A slight bulge at the bridge area is permissible. Lay a straightedge (at least 18" long) across the top of the guitar just behind the bridge. If measurement from the top of the guitar to the bottom of the straightedge at the outside edges of the lower bout is greater than ¼", you likely have a pulled top and quite possibly some cracked or unglued bracing inside. Once again, these conditions should be rectified before proceeding with the action adjustments.

PLAYING STYLES AND STRING GAUGES

When a customer brings in a guitar for action adjustment, I ask them to demonstrate a typical playing style and attack. Obviously, a heavy attack (i.e. hard playing) with a flatpick requires a higher action than a soft, fingerpicking style. If volume is not a major consideration, many fingerpickers prefer a low action and light-gauge strings. If a fingerpicker uses thumb and fingerpicks and volume *is* a consideration, then a medium action may be appropriate. Flatpickers, on the other hand, generally favour medium-gauge strings and a medium action. For bluegrass and slide work, a medium to high action may be in order. Regardless of the playing style, action adjustments should be carried out with the gauge of string to be used. Any subsequent change in the gauge of string will likely require some alteration in the action setting, as each gauge has a different tension. A short note on heavy-gauge strings: DON'T USE THEM! Heavy-gauge strings exert an incredible amount of pull on the bridge and neck: I have seen them buckle more than a few guitars. Unless you really know what you're doing and are positive that your instrument has been constructed to withstand the pull that these strings exert, stay away from them.

TOOLS REQUIRED

In order to carry out action adjustments, one should use the proper tools, most of which can be purchased from a local hardware or hobby shop. These include a set of needle files, a small ruler graduated in 64ths of an inch, a fine-toothed back saw, an 8"-10" mill bastard file, a set of mechanic's feeler gauges (for measuring relief), a pair of end nippers or pliers, and an assortment of small screwdrivers and nutdrivers, as well as the appropriate Allen wrench

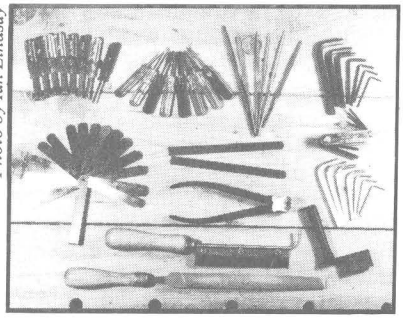

Photo by Ian Lindsay

Fig. 1: tools required

or nutdriver to adjust the truss rod in your guitar (see fig. 1). If you find that you must acquire these tools from scratch, the cost of purchasing them ($30-$40) will exceed the cost of having a qualified repairer adjust your action for you (provided all else is in order). However, if you remain undaunted, my best advice is to summon up a reserve of patience and work *slowly*. (Careful with that axe, Eugene!) It is imperative that the following steps be carried out in the proper sequence. That is to say: 1. truss rod adjustment (if necessary) 2. adjustments at the nut 3. adjustments at the bridge saddle. A different order will wreak havoc with your guitar.

TRUSS ROD ADJUSTMENT AND RELIEF

Contrary to popular belief, the neck on a steel-string acoustic guitar should not be perfectly straight. As you sight down the neck from the head, you should be able to see a very gentle downward bow in the neck. This is referred to as "Relief". A vibrating string vibrates in an arc. The greatest arc is at the midpoint, the 12th fret. Because guitar necks are set at a slight angle to the plane of the top, the string has plenty of room to make the arc from the 12th fret to the bridge. It is the arc the string makes between the nut and 12th fret that we are concerned with here, and thus the reason for relief. This slight bow in the neck allows the string to vibrate freely without rattling against the frets. As a rule, the lower the action, the more critical the relief.

How do you tell if the truss rod in the neck needs adjusting? Simple. Sight down the neck. If the neck is perfectly straight, bowed up towards the strings, or has a pronounced downward bow, the rod is in need of adjustment. There is a limit, however, to how much bow can be adjusted with the truss rod. Keep in mind that the truss rod will only adjust bow between the 5th and 12th frets, and, generally speaking, only a small amount of bow at that. No amount of truss rod adjusting will correct a badly warped (in either direction) neck.

There are a number of different types of truss rods. Some are adjustable, others aren't. Those which are most often have a triangular piece of plastic covering the adjustable end located on the headstock just behind the nut. Remove the covering plate and loosen the third and fourth strings, leaving the others up to tension. Insert the appropriate Allen wrench or nutdriver to adjust the rod. If the neck has too much downward bow, the rod will have to be tightened by turning the wrench clockwise (assuming you are standing at the tuning head end of the guitar with the body away from you). Work slowly and in small increments (i.e. ⅛ to ¼ of a turn at a time), wrestling the neck and allowing it a few minutes to settle between turns. If the neck is straight or bowed slightly upwards,

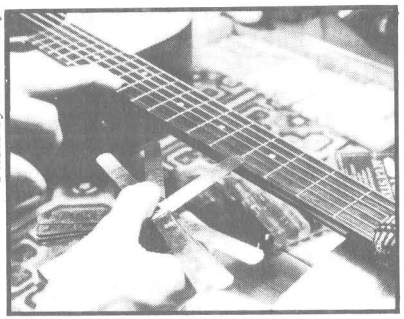

Photo by Ian Lindsay

Fig. 2: measuring relief

turn the wrench counterclockwise, again in small increments. While doing this, you should be able to feel the rod tightening or loosening according to the resistance on the wrench and the force required. Work slowly, periodically sighting down the neck to check on changes. When the neck appears to have that characteristic gentle downward bow, tune up the third and fourth strings, put a capo on the first fret and hold down the high E string at the 12th fret. Here the string is acting as a straightedge. Get out the feeler gauges. Relief is generally measured at the 5th fret. Ascertain which gauge will slip between the 5th fret and the first string without pushing the string up (see fig. 2). The reading on the feeler gauge will tell you how much relief is in the neck. An ideal relief is between .015 and .020 (readings indicate thousandths of an inch).

Other types of truss rods adjust through the sound hole, but the procedure is the same. If your neck is bowed upwards towards the strings and you have totally slackened the truss rod and it has not corrected the problem, or, conversely, if the rod is very tight and there is still too much downward bow, then you have a problem indeed! As mentioned previously, there is a limit to how much bow can be adjusted with the truss rod. If the truss rod fails to correct the problem, the solution involves further repair techniques such as straightening the neck by heat treatment or pulling the frets and planing the fingerboard. A final note: there should be a minimum tension on the truss rod at all times, as a totally slack rod may rattle in the neck.

TAKING ACTION MEASUREMENTS

The first step in adjusting the action consists of taking readings of the present action to gauge how much to alter the settings. Place the 64ths rule on the fingerboard against the nut on the treble side and take a reading of how high the treble E or first string is above the fingerboard. Read this carefully! It should be in the region of 2/64ths to 4/64ths. Next, place the rule ON TOP OF the 12th fret and read again. Place the rule on the guitar top as close to the bridge as possible and read again. Repeat all measurements on the bass E string at the nut, 12th fret (see fig. 3) and bridge. Readings at the 12th fret should fall in the 4/64ths to 10/64ths range and

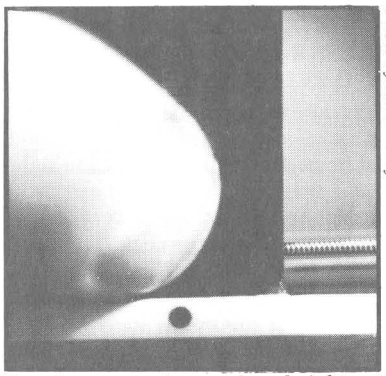

Photo by Ian Lindsay

Fig. 3: measuring string height at 12th fret

readings at the bridge should fall in the 20/64ths to 32/64ths range. It is of the greatest importance that these readings be taken accurately. String height readings are only taken on the first and sixth strings. The other settings are averaged out between the two, remembering that string slots in the nut should follow a curvature that matches the curvature of the fingerboard. (Likewise the bridge saddle should have a similar curvature along its top).

NUT ADJUSTMENTS

For several reasons, most factory-made guitars have a high action. A low action may result in buzzes that will kill a sale. It is assumed that the player will have the action adjusted to best suit his or her playing style and preference. Also, it is easier to lower an action than to raise it. Lowering the action at the nut merely consists of cutting the string slots deeper and filing the top of the nut. This can be done with the nut still glued in place. Slots for the first and second strings should be deepened using a fine-toothed back saw or razor saw. Again, I emphasize, work slowly. One heavy pass can deepen a slot a couple of 64ths. Slots for the third through sixth strings should be deepened with a tapered file and then contoured to shape with rounded needle files (to gauge how much to deepen the slots in the nut see fig. 4) Keep in mind that strings should only sit up to half their diameter in the nut slots, hence the reason for filing the top of the nut. When you have arrived at the desired depth, remove the strings from the top of the nut and, using a mill bastard file, file the nut top down until this is the case. Finish with 320, 400 and 600 sandpaper.

Fig. 4
*Table of String Heights**
**All readings indicate 64ths of an inch*

Action	Nut		12th Fret	
	B	*T*	*B*	*T*
Low	3	2	7	5
Medium	4	3	8	6
High	5	4	10	8

String height at saddle varies widely according to guitar model. General range is 20/ to 32/64ths.

If the action is presently too low at the nut (this will show up as buzzing, even after the truss rod has been correctly adjusted), you have the option of shimming the existing nut or making a new one. Remove the strings (and the truss rod cover plate, if there is one) and crack off the old nut with a sharp, moderate force blow from the fingerboard side. Using a knife or a chisel, clean out any dried glue that remains. Shimming should only be done if the old nut was just slightly too low. Wood, bone or light cardboard (such as cigarette package cardboard) can be used as shim stock, but the total thickness of the shim should not exceed 1/16". If the nut needs to be raised more than this, you are better off cutting a new nut. Bone nut blanks can be purchased at most music stores.

Rough out a new nut to approximate size, using the old nut as a guide (don't forget to make the new nut higher!). The old nut may also be used as a guide for the size and spacing of the string slots if the old spacing was correct. Glue the new nut in place with white glue and let dry. Then proceed with the notching as above. When making the slots, keep in mind that they should angle down toward the peghead as well as angle toward the tuning post that the string

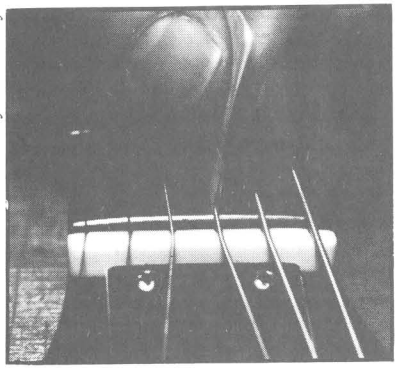

Photo by Ian Lindsay

Fig. 5: checking "zero fret" contact

in that slot is going to. In the case of guitars with a "zero fret", that is, a fret immediately adjacent to the nut, the slots in the nut must be deep enough so that each string firmly contacts this zero fret. I have found that you cannot rely on your eye for this task, so I've come up with a sneaky test. Take a zig-zag paper, slip it under the string in question and run it up against the zero fret (see fig. 5). If the paper slides between the string and the fret, or catches between the two, the nut slot must be deepened. On guitars with this zero fret, the nut merely acts as a string spacer. The zero fret functions as the nut. Consequently, action at the zero fret is only adjustable by filing or by replacing it with higher bead fretwire.

BRIDGE SADDLE ADJUSTMENTS

With the truss rod properly adjusted and the nut set at the right height, all that remains is to adjust the bridge saddle. With the strings all up to tension, place a capo at the 1st fret. With the capo on, the midpoint is now the 13th fret. Measure from THE TOP OF the 13th fret to the bottom of the first and sixth string. Compare these measurements to the 12th fret (yes, 12th fret) measurements in fig. 4. How do they compare? For the sake of example, let's say you're after a medium action. Let's also say that your measurements have yielded 10/64ths bass side and 8/64ths treble side. What you want according to fig. 4 is 8/64ths and 6/64ths respectively. Now, since with the capo on, the 13th fret is the midpoint, any amount added or subtracted here (i.e. 2/64ths) must be DOUBLED at the saddle. Think about it for a minute. In order to lower the string 2/64ths at the 13th fret, you must lower the saddle by 4/64ths, or double the amount. When determining how much to lower a saddle, I don't go by the table alone (fig. 4). I place a finger on the high E string and slide it up the neck one fret at a time, pausing briefly to see how the string clears the next higher fret. There should be a small gap, about the thickness of cigarette package cardboard, between the string and the next higher fret. Try the same on the bass string, allowing slightly more room

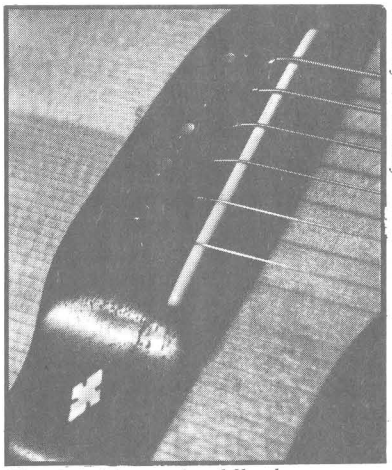

Photo by Ian Lindsay

Fig. 6: bridge and saddle close up

this time. If both the bass and treble strings clear the frets with ease, then I'd use the table settings. If they don't, I'd aim for a slightly higher action and bear the new information (that the strings are quite low already) in mind.

Bridge saddles are not generally glued in place and once the strings are removed usually come out quite easily. However, from time to time, some merry prankster glues one. The best tool to remove a stubborn saddle is a pair of end nippers (centre, fig. 1). Pliers can be used, but I don't recommend them: it's somewhat akin to trying to extract a cracked egg from its carton with a Stillson wrench. Use a gentle, rocking motion with the nippers. If the saddle is merely a tight fit, a bit of patience will meet with success. If the saddle seems glued in place, mask off the bridge and work on it in place.

If you do manage to remove the saddle in one piece, inspect it. Fingerboards on steel strung guitars generally have a slight curvature from the bass side to the treble side. The saddle should have a corresponding curve. Also, the saddle top should be rounded across its length in the direction the strings pass over it (see fig. 6). The saddle should not be grooved in any way for the strings and should sit in its slot such that only one third of its height is protruding above the top of the bridge. In addition, as you may have noticed by now, measurements at the nut are always 1/64th inch more on the bass side, measurements at the 12th or 13th fret are always 2/64ths inch more on the bass side, so it stands to reason that at the saddle, measurements on the bass side will exceed the treble side by 3/64ths to 4/64ths inch. Once the top of the saddle has the proper curvature both ways, all that remains is to file or cut the appropriate amount off the bottom. For this job you can use a file for removing a small amount or a razor saw for a larger amount. The saddle top can be shaped with a file and smoothed with 320, 400 and 600 grit sandpaper.

One thing to watch for while adjusting the saddle height is that the top of the saddle protrudes at least ⅛th inch above the top of the bridge. If the top of the saddle is lower than this, the strings don't have a sufficient angle of breakage over the saddle and a thin or dead-sounding string will result. There are several ways to remedy such a problem. One is to shim. Another is to remove the strings, bridge pins and saddle and plane or sand down the top of the bridge. However, if you don't have any previous woodworking experience, you can make quite a mess here. If you do follow this route, mask off the top of the guitar with cardboard and work slowly. A third solution involves making ramps for each individual string. Remove the strings, bridge pins and saddle. With the razor or backsaw, cut grooves for the first and second strings from the pin hole to within

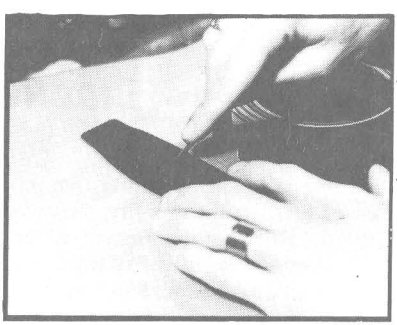

Photo by Ian Lindsay

Fig. 7: filing string ramps

about ⅛ inch of the saddle slot. These should slope smoothly into the pin hole at about a 40 to 45 degree angle in relation to the plane of the top of the bridge. As with working on the slots of the nut, the remaining ramps can be started with a tapered file and rounded to the appropriate diameter with half-round needle files (see fig. 7). Because most saddles on steel strings are compensated, or slanted, as you work toward the sixth string, your ramps will become increasingly shorter, but the angle should remain constant. A final touch to a bridge that has been reworked is to use an electric drill and countersink bit and lightly chamfer the tops of the bridge pin holes (see fig. 8). The final clean-up involves sanding the bridge with 400 and 600 grit sandpaper and waxing it to bring up the shine and preserve the wood. Replace the saddle, strings and pins, and tune 'er up!

If you have followed the steps outlined above carefully and in the proper sequence, you should end up with a guitar with an action that is suitable to your style of playing. As with most things, however, practice makes perfect. My first attempts at setting actions were successful but incredibly

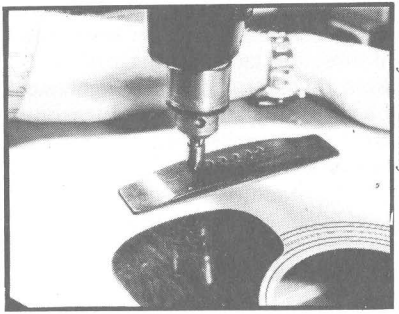

Photo by Ian Lindsay

Fig. 8: chamfering bridge pin hole tops

time-consuming. I could always cut a little more off, but if I cut too much. . . . This is why I stress patience and slow work. You're the one who has to live with your own action job. Trying to rush through it will produce sloppy results. Allow yourself several hours, if this is your first time. If you find that you enjoy this kind of work and want to learn more, there are a number of good to excellent books on guitar construction and repair on the market. I refer you to David Miller's excellent review of the available literature in *Canada Folk Bulletin,* Vol. I, No. 4 (July-August 1978).

Bruce Martin