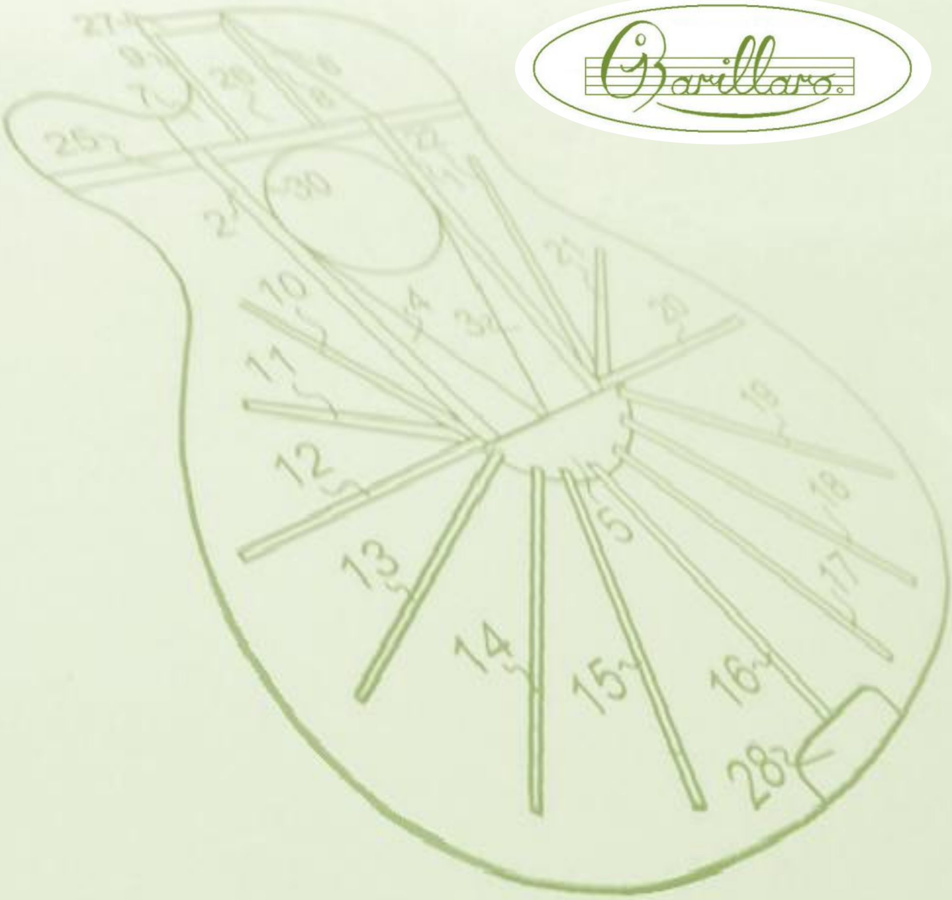
BARILLARO GUITARS



INSTRUCTION MANUAL for BUILDING the Indirect Bracing Structure (IBS) System ACOUSTIC GUITAR

INCLUSIVE WITH FULL SCALE PLANS

FOR LUTHIERS and NOVICE GUITAR BUILDERS

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MEMO

1. **Follow these instructions and succeed.**
2. **Don't be tempted to modify any part of the indirect bracing structure IBS System, not at least, until you have built a working model.**
3. **All angles and dimensional measurements of the block and brace work need to be as specified.**
4. **Placement and Gluing of parts to the soundboard should be done as accurately as possible.**

INTRODUCTION

While this book is a manual for the construction process of the Patented Indirect Bracing Structure (IBS) System, It also covers the finer points and details of special technical concern for the building of an Acoustic Guitar.

Taking a look at the plans you might be wondering where to start, if you're a Luthier and have built acoustic guitars before, then you will probably have your own procedures and set ways of doing the major construction processes. However, for the best result and for the novice guitar builder, I will give an outline of the procedures I use. The BACKGROUND CONTENTS contains general as well as specific information: such as how to choose, split and recut your instrument timber; the equipment generally used to make a guitar; different glues and the necessity of a humidity controlled dry room. Throughout the manual I will also discuss important construction methods and the technical aspects surrounding the building of an Acoustic Guitar, especially with regards to the IBS System. Hope you have fun building and eventually enjoy playing this exceptional musical instrument.

BACKGROUND CONTENTS

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BACKGROUND INFORMATION for the GENERAL CONSTRUCTION PROCCESSES of an ACOUSTIC GUITAR including the IBS SYSTEM

Choice of Timber

For **the soundboard** I often use Spruce grown from any cold climate location, but I have used other timber species from moderate climate locations, with surprisingly good results. I recommend choosing a soundboard that has **a good amount of spring when flexed,** in the same direction as to the annual growth lines. The soundboard and bracing timber should be well seasoned, as explained in the Tech Info pages under the heading of Choosing Musical Instrument Timber by the Tap Tones Selection Method. (barillaroguitars.com)

The growth lines of the soundboard can be anywhere between 0.5 to 2mm wide, but more importantly a well quarter cut soundboard makes for a better soundboard and will show up cross grain cellular fibre growth; indicating that the longitudinal cellular wooden fibres are more so continues, than not. While the gap in growth lines of a timber soundboard may vary greatly with little appreciable difference made to its tonal abilities, the same cannot be said for the bracing wood that's used for the support structure…

Bracing wood needs to have a very tight grain between the summer growth lines. Spruce again, is a good choice but other species of pine can also make good bracing wood. Provided it is free of excess sap and, has a strong stiff-spring to flex-feel about it. For my IBS system I recommend a minimum gap of 1mm between annual growth lines and less than 1mm is better!

The timber species used to build the **sides and back of the guitar** are generally chosen by an individual's personal choice, but usually with regard to tonal characteristics'. However I feel it's necessary to give a word of caution here, that is, with the harder or denser species of timber such as Brazil or Indian Rosewood one really needs the timber to be very well seasoned and free of excess sap in order that it will respond stiffly to vibration. For whichever species of timber is used, I recommend that a comparison should be made between different samples of timber you are intending to use. Once the timber has been cut and thicknessed to size a comparison may be made of its spring to flex resistance ability, by flexing the sample across the grain and along the grain.

Preference in **guitar necks generally undertakes a personal choice**, the shape of the back of the neck and the width of the fret board, are usual personal considerations. The timber that may have been used to make the neck however, is usually a last consideration. From a structural point of view, the neck needs to be made from a dense harder wood sample of the same wood used for the back and sidewalls, so it will resist vibration firmly. Timber samples from the same species vary in density and so it should be easy enough to find denser sample for the neck. However, if a denser sample is not available of the same timber species, then it is nearly always possible to find a hard-wood species, similar in texture and colour. While the truss rod inside the neck counteracts the static string load tension well enough, consideration of the truss rod system will show it's just a spring loaded counter force; it really does help to use a strong denser species of wood for the neck in order to resist ongoing string vibration.

A wider neck around the nut end, not only strengthens the neck against absorbing string vibration, but also allows the player to more easily and accurately produce a clean sound when fingering a melody. A neck made with a flatter curve to the back of the neck, allows for quick finger movement.

Soundboard Timber Thickness

Soundboard timber is usually supplied pre thicknessed, but otherwise a spruce soundboard 3/32" of an inch thick should be used and 1/8" thick for softer timber soundboards, such as American western red cedar.

Brace Wood

An important step is to first split your brace wood. Take a small block of spruce long enough to make the braces, stand this up on one end, using a heavy blade placed parallel with the end grain on the top of the block strike the blade with a mallet to split the wood in half. The split face should show a near blank face free of annual growth lines, see Fig 1. SPLIT BILLET. Once split, the two split faces of the billets of wood are sanded down flat. Using these flat faces hard up against the fence of a bandsaw, recut the billets into wafers thick enough for the bracing width material; allow a little more for sanding, see Fig 1. SAWN WAFER. The wafers also need to be split but this time place the blade or a chisel across the annual growth lines, on the top edge of a wafer to split it. This process will show up the natural line of the wood fibre which is also sanded down flat and used as a guide to recut the wafers into long bracing blanks. One side of the brace with annual growth lines is used to glue down on to the soundboard.

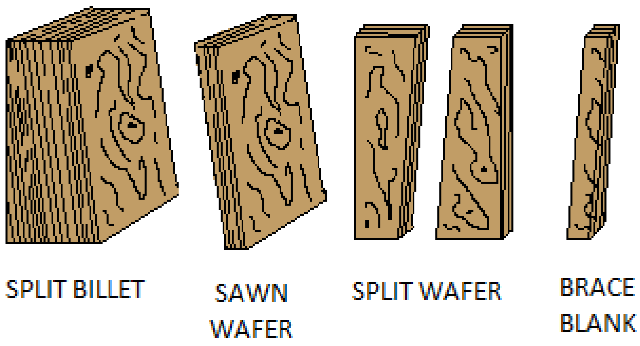


FIG 1. Different stages of split and resawn brace wood.

Shaping the Sides

On the bass side shoulder, you will notice there is a slight up and then downward curve that becomes straight as it meets up with the body junction of the 14th fret. I highly recommend holding to this given shape for the body outline of the plan, for both the bass side shoulder and for the treble side curved cutaway side. Even though the line of the bass side shoulder may seem to be an added aesthetic addition, the dip in the bass side shoulder has actually come about by design purpose. The design purpose behind this shape is to be able to sink the neck further in towards the body enabling the bridge to be located more so central with the bottom side bouts of the body. The curved dip in the bass shoulder simply allows this side of the body to meet up with a 14th fret body junction again.

Modifications to the sidewall shoulders of the guitar body however may be made, the criteria needed is to keep the bridge on the plan where it is. Moving away from the traditional dreadnought square shoulder look, you could instead form a more rounded shoulder shape, which would meet up with the 14th fret body junction, In doing so, you may also have to move the waist, inwards a little; this would be ok but avoid going too far in.

Furthermore if you prefer not to have a curved cutaway shoulder on the treble side of the guitar, you could simply mirror the bracing block work of the bass side of the soundboard, to the treble side of the soundboard.

Modifications to the body shape should not be undertaken lightly, you should first build the guitar as specified on the plan, before undertaking any changes to the line or size of the body. As already mentioned the IBS System locates the bridge on the soundboard more so central with respect to the bottom half of the body; between the waists and tail block. If the shape of the body sidewalls is altered then you should also consider a design strategy, where the distance of transverse alignment of the bridge to the sidewalls on the soundboard is not reduced.

Modifications to the braces and blocks: 1, 2, 3 and 4, should not be attempted. The dimensional sizing and parameters of placement of these blocks have been worked out using mathematical formulae and scientific principles. There are many mathematical variables which are taken into account belonging to several formulae where the formulas are reworked together to attain a balanced unique dynamic response. An explanation as to the workings of these formulae is beyond the scope of this book. However working through this manual to build this acoustic guitar should provide an appreciable insight as to the workings, of the IBS System design.

EQUIPMENT: What to use, a GUITAR BODY MOULD or a GUITAR BODY WORK BOARD?

It's probably well known by now that it's not a good idea to squeeze the bent sidewalls of a guitar into a solid preformed mould; in order to keep exactly to a designated body outline. In short wood has a memory, squeezing the sides into a designated shape by force puts spring tension into the sidewalls that constantly remains. After gluing the top onto these sides the spring tension in the sides will interfere with the string vibrations passing through the soundboard. My indirect bracing structure (IBS) system is designed to largely remove all the string load tension away from the soundboard, so that it is able to vibrate uniformly, free from any preplaced stress; with due consideration to the above discussion I do not use guitar moulds or place any undue force on a prebend side to match an outline. However, in saying what I have there is no need to worry over an easy movement in the sidewalls of 1 to 2 mm, I would not class this as undue stress.


PICTURE 1, GUITAR WORK BOARD 1

I use a guitar work board to hold the guitar body and neck while it is being built. I don't worry about any minor discrepancies in the outline of the body, normally they are never noticed. If the discrepancies are obvious, then simply I will just reform the side on the bending iron. From an acoustics engineering point of view, there is nothing to be gained from any special curved outline made to an acoustic guitar body; however, one should consider if a change in outline is going to increase or decrease the cubic volume of air within the body.

Looking at Picture 1, the guitar work board I use shows a removable *adjustable neck support and a tail block* support for the sides, the support pieces are screwed to the work board edge. Other not so wide support pieces may also be screwed to the work board edge to support the sides at different locations; at the waists being one other practical location. The cup head screws fitted to the edge of the work board (spaced at approximately 30mm), are used to hold 3mmD elastic shock chord. The elastic chord is used for many different gluing jobs, like gluing the back onto the sidewalls. The work board can be made from two sheets of 19mm structural ply laminated together. <u>A straight level length of stable timber</u> 100mm x 40mm is fixed to the underside with screws through the work board and is used to ensure a level working area. This underside T Section length of timber fixed to the work board can be secured into a bench vice at any point along its length, as shown in Picture 1.

PICTURE 2, GUITAR WORK BOARD 2 INSERT

Another useful work board is shown in Picture 2 and is inserted between the major work board 1 and soundboard of the guitar body. The sandwiched work board 2 is used to take up the space, thickness of the bridge and fret board. A thin white cardboard cut out is also put on top so as not to damage the soft wood of the soundboard. Examples for the use of these work boards are in the following pages.

Humidity

I build my guitars at a relative humidity level of 45%. All the timber used for building the guitar should be kept at this level, or even a little lower when gluing parts together. To safe guard the guitar from higher humidity levels whilst waiting for a glue job to set on the work board, I wrap clear plastic covering all-around the guitar body and work board. For overnight or extended periods of storage, the guitar body including any loose bracing parts should be stored in a large clear plastic bag. For the guitar builder who only makes a small quantity of guitars, usually a small dry room is set up with an air conditioner and heater, and is sufficient for gluing and storage.

Guitar bodies are built under these stringent conditions, with a relative humidity level of 45% to stop their soundboards, sidewalls and back-plates from cracking. A timber soundboard will stabilize its self to the surrounding atmospheric conditions of humidity levels. By the absorption or evaporation of water content, relative to its self and to how much is present within the air. The absorption or evaporation process takes place largely across its annual growth-lines, causing the soundboard to either expand or shrink in this direction. Very little movement actually takes place along the direction of the annual growth-lines of the soundboard. By example, if a brace is glued across the annual growth lines of a soundboard, at say a relative humidity level of 65% or worse 85%, this brace will hold the timber soundboard at this expanded dimension regardless of any change in humidity levels. Since within the length of the brace wood, there is virtually no movement relative to a change in humidity levels.

If the guitar body were to be built at a relative humidity level of 65% to 85%; in dry conditions when the relative humidity could plummet to just 20%, the body of the guitar and soundboard will lose water content and form cracks. Since the soundboard is forced to shrink while held by braces, at its larger expanded dimensions of 65% to 85%.

To prevent cracks from occurring, the guitar body is simply built at a relative humidity level of 45%, in dry conditions it will therefore only be stressed to shrink by a small amount. In higher humid conditions the soundboard, sidewalls and back-plate are actually able to expand safely. This is due to their free outside surface areas ability, to absorb excess moisture and cup up.

Glues

In the assembling process I mainly use two types of glue: High Stress wood glue that's made from "Melamine Fortified Urea Formaldehyde", this glue comes in a white powder form and is mixed with a catalyst hardener and water; this glue sets rock hard and is not reversible by heating. This glue in particular should not be heated or machined since the fumes released are a hazard, however when set this glue is a stable substance and non-toxic. Another type of glue which can be used and sets hard is a marine two part epoxy resin, mainly used on boats for sheathing but is also used with added extenders to make a glue or glue filler. The glue extender is usually made from exploded silicon and has a white soft fluffy powder appearance. I add very little of this extender to the glue mix if I am using it to glue up braces, as it will soften the set glue into a more flexible plastic like glue product.

Why all the fuss about what glue to use for the assembly process? Glues that set into a soft rubber like substance or even into a soft plastic like substance have an ability to flex and so hold glued wooden parts together very well when exposed to all weather conditions, because they are able to stretch to some degree. The other wanted or unwanted ability of these glues is that they are able to absorb vibration very well. The soundboard bracing structure including the bridge, should all be assembled to the soundboard using only a glue product that sets rock hard to form a total one piece structure that is able to pass vibration well without loss!

There are other glue jobs however that are done on the acoustic guitar that can only be done using Poly Vinyl Acetate (PVA) glue, such as gluing the fret board to the neck or a nut to the end of the fret board. Super glue has been used extensively of late to repair lacquer chips and cracks, but is also a hazard and should not be machined; do not use super glue for braces etc.

String Scale Length

If you have built guitars before you will know just how important it is, to correctly set out the distance from the nut to the bridge saddle. For the correct string scale length, a little extra length is added to the theoretical string scale length, to compensate for the difference made in string tension, which occurs when a string is depressed onto a fret. This extra added length given to each string of the scale length is called string compensation and varies due to: the String Length used for the instrument, for the String Gauge used and for the String Action that is set. The *string action* is the distance set between the top of the 12th fret to the underside of the string. For the following string gauges a *standard string action* is set at a maximum 1/8" for the low E string, gradually reducing down across the other strings to 3/32" for the high E string. The string action also includes the height of the string above the 1st fret and is easily set by holding the string down at the 3rd fret and checking the space between the 1st fret and string. This space should allow the thickness of a photograph paper, to slip in-between easily. This method is independent of the set saddle action but should be done before hand.

The string scale length on the plan for the IBS System is set at 25 & ½" and works best for a regular string gauge set of 0.012, 0.016, 0.022, 0.032, 0.042, and 0.053 inches. The extra string length compensation needed for this scale length and string gauge set, works out as given in Table 1:

STRING NOTE	GAUGE INCHES	COMPENSATION INCHES
E	0.053	3/16
A	0.042	1/8
D	0.032	7/64
G	0.022	3/32
B	0.016	near 1/8
E	0.012	1/16

Table 1

Fret-Board

For the novice guitar builder a precision 25.5 inch scale length, pre-cut slotted fret-board may be purchased from a lutherie supply. If however, you want to cut your own fret slots, I strongly recommend the purchase of a stainless steel fret scale ruler. However, do not use the scale marked positions that are provided on the plan, due to shrinkage and or expansion of the paper they may be incorrect.

Scale length fret positions for a musical instrument's fret-board can be worked out in more ways than one. A common way of doing it is to use 18th Rule or more precisely 17. 817; the location of the Nut to the 1st fret is found by dividing the scale length (25.5") by 17.817, = 1.43122 inches. The scale length minus this distance (25.5 – 1.43122 = 24.0688 is the remaining scale length) is then divided again by 17.817, to find the next fret interval (=1.35089), from the 1st fret to the second fret. This process is repeated to find all the fret intervals.

Gluing the Bridge to the Soundboard

Once all the soundboard bracing and blocks have been glued in place, the bridge can be glued to the soundboard. As previously mentioned the bridge can be set in place using a loose fitting pin nail through the 1/16" hole that was drilled into the soundboard; this hole may have to be redrilled due to the previous glue jobs but don't drill all the way through

Picture15

the Trans Lobe and cut the point end of the pin nail. With the pin nail in place measure out half the string length, 12& ¾" from the centre of the 12th fret plus 1/16" string compensation, for the location of the high treble E string side, that will sit on the saddle. At the saddle slot, this point location should go over the 1/8" saddle slot by only 1/32" see picture 15. Whereas for the low bass E string side, string compensation is plus 3/16" and this string point of contact should be set closer to the backside edge of the saddle closest to the bridge pins. These measurements will allow all string length compensations to fit well onto a 1/8" thick saddle, for a string gauge set of: 0.012, 0.016, 0.022, 0.032, 0.042 and 0.053 inches.

Picture 15.1

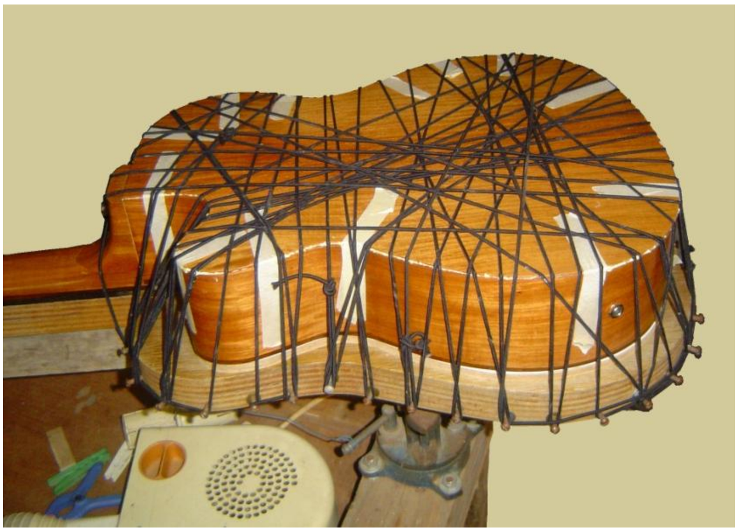
Using two deep throat clamps to hold down the bridge in place, drill two holes in the soundboard through the bridge pin holes, to take two small bolts. When gluing the bridge down these bolts with a nut and washer are used as clamps to secure the bridge in place, along with the two deep throat clamps, see pictures 15 and 15.1.

Use a glue that will set rock hard to glue the bridge down. While the bridge is glued down and the glue is still soft remove the pin nail and allow the hole to fill up with glue. After the glue has set and the deep throat clamps are removed, the star head bolts will simply unscrew out but if the threads of the bolts had first been lightly oiled they should unscrew easily.

At this point the bridge pin holes need to be drilled out and shaped with a bridge pin reamer; a word of precaution, don't trust the reamer to make the final snug fit to the bridge pin hole, use a small rats tail file to do this. The edges of the bridge pin holes need to be counter sunk a little and a rounded slot made into the edge of the holes to stop the string making a sharp bend as they come out of the bridge pin hole, see Fig 4 and picture 15.

Gluing the Back-Plate on

As before set the guitar down onto the work boards and make sure the face of the fret board is level with the soundboard, as before place a shim between under the end of the fret-board face and work board. Check that the back will fit well onto the sidewalls. A bead of glue is applied only to the top of the linings; masking tape is then used to temperedly hold the back-plate on. The elastic shock cord is then wrapped around, to hold the back-plate down while the glue sets, see picture 16.



Picture 16

The Fret Job

When making an acoustic guitar, doing the fret job is one of the most demanding jobs you can do; there are many aspects about this job that need to be taken into consideration as follows:

• First up, the face of the fret board should be very close to level with the top-face of the bridge and parallel to the soundboard. Although, this being the case (before the guitar is strung up), the Nut end of the neck, should also be allowed to rise-up, by the tension of the strings. The resulting bowing-up, gradual contour along the face of the fret board (from the nut to the 12th fret), is called ***string relief*** and prevents, string slap buzz. Strings vibrate naturally in a curve, (not in a straight line) so by having a curved fret-board string slap buzz is avoided. You can measure this distance on a guitar that is already strung up, by using the string as a straight edge, fret the low E string with a capo at the 1st fret and hold it down at the 12th fret while you measure the distance between the top of the 5th or 6th fret to the underside of the string. This measurement should be a minimum of 1/32", a little more 3/64" is better for heavy strumming.

• As a result, due to the set of the bow placed into the neck and fret-board, the straight line of the string will lifts up. The action at the 12th fret of the string will of cause have to be lowered, once again. Consequently, the straight line of the string is no longer parallel to the surface of the soundboard. Therefore, the straight line of the fret board, from about the

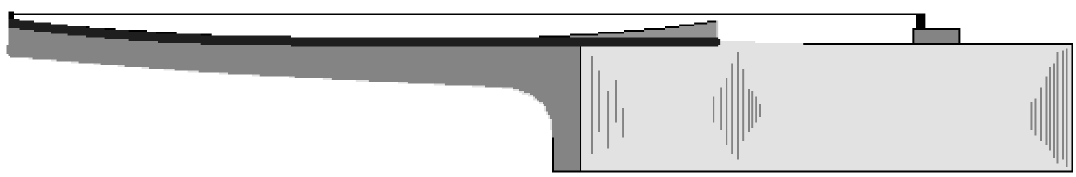


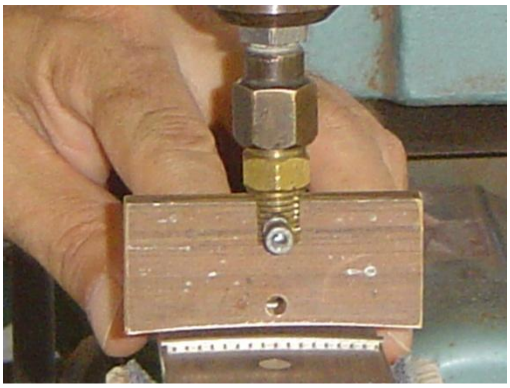
Fig 7 shows an exaggerated view of the bow in the neck, with the rise of the fret board from about the 12Th fret to the sound hole to be sand down.

12th fret to its end at the sound-hole, will appear to be rising up towards the string. Fretting a string in a higher position say from the 5th to 10th fret will then create slap buzz once more. So, the slight curve in this area of the fret-board rising up will have to be sanded down flat, see Fig 7.

•To perform the sanding work needed on the fret board before inserting the frets, loosen the truss rod and place the guitar on a work bench with the end of the neck supported underneath by a padded block of wood. Using a long straight edge flexible stainless steel ruler, with its edge placed along the top face of the fret board, press the centre of the neck down to approximate the curve of the fret board string relief required. By doing this, you will be able to see how much rise there is, from about the 12th fret onwards to the sound-hole. Sand this section down while you periodically check the area with the straight edge, and use a 12" radius template to check for the correct fret board radius. The bow in the neck fret-board should eventually after sanding, stop at the 12th fret area; with the remaining face of the fret board towards the sound-hole, sanded down level to the straight edge ruler.

Inserting the Frets into the fret board slots can be done the easy way, or the traditional hard way by using a small hammer to tap them in place. The easy way is to use a drill press fitted with a self levelling arbor, having a 12" radius to press the frets down into their slots. Commercial arbors are usually supplied with a set of caul inserts (each having a different radius). This method of pressing the frets down ensures the frets are more evenly seated, to one another. So, when it comes to doing the job of levelling the frets and re-rounding them, there is less work involved, see pictures 17 and 17.1. It's a good idea to pass a triangle file over the fret slot

Picture 17



Picture 17.1

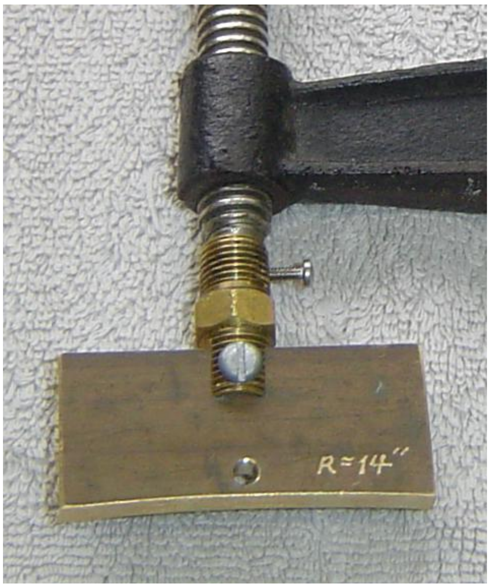
edges, to prevent chipping of the fret board when removing frets, due to a re-fret job.

Picture 17.1 an enlargement, shows a simple self levelling homemade arbor and caul all in one being used.

The frets should all be prepared to length with the correct 12”radius and have their tangs nipped at each end. White PVA glue is squeezed into the fret slots with a syringe to glue the frets down; this will prevent fret movement over their serviceable time period. The frets can be easily removed by passing a small soldering iron over the crown.

Picture 17.2

Over the body the frets are pressed into their slots using a specially adapted clap; these claps are also commercially available, see pictures 17.3, & 17.4. The white screw up knob stops the slide bar moving while the fret is positioned properly. The screw protruding from the simple brass (gas pipe) fitting used to make the arbor, locks it to the ball end of the clamps threaded rod.



Picture 17.3

Picture 17.4

Picture 17.5 shows the clamp in use; the sliding bar of the clamp however, should be well padded with a soft rubber sleeve to prevent damage to the edge of the sound hole.

Picture 17.5

Levelling the Frets is normally done with a fine tooth flat file. There are many other tools available to level the frets; an old favourite of mine is a flat level 8”x 2”x 1”, very fine silicon carbide sharpening stone. I use a water dispersant spray like WD40 to clean it, while doing the job. To start the job the fret board should be covered with masking tape between all the frets. Use a straight edge to check the fret board is level, at this point there should be no bow in the fret board, if there is then straighten the neck by using the truss rod. If the frets were pressed in, they should then level down very quickly. Start at the nut end of the fret board and level the crowns of the first 4 or so frets, using the stone with only the slightest of pressure. Be aware that you may be pressing a curve onto the neck while trying to level the frets, by applying to much pressure. The tops of the crowns need only show they have been touched by the stone, keeping the crowns as high as possible is an important aspect of the fret levelling job. Work your way along the neck and check as you go with a short straight edge covering 3 to 4 frets initially, to see if there is any frets rising higher between adjacent frets, producing a see-saw effect.

Re Rounding the Frets is done efficiently by using a triangle file that has had its edges grinded off, guided by a scraper blade to one side of the fret. A little less than 1/32” can be left on the top of the crowns, after which are polished off in the direction of along the fret with supper fine sand paper and steel wool.

Bevelling the ends of the frets is done at an angle of 35°; the file used for this job should have its serrations of the file, running only at one angle. The cutting action of the file is then directed downwards. This prevents any one end of a fret being filed to lift up, from its slot. Again there are many commercially available tools to do this job; some have the file mounded onto a block at the correct angle with the block sliding over the top of the fret board, as a guide.

Stringing up the Guitar-The Set-Up Job

The saddle and Nut should preferably be made out of bone blanks or at least from a material similar in density. The saddle and nut need to be able to pass on vibration, not absorb it. Commonly used plastic saddles and nuts are largely made of soft plastic that bends easily, some of the better ones are much stiffer; but even replacing these with bone, always improves the tonal sound quality of a guitar. Bone does have its problems with the two high plain steel strings B & E, if the strings on the guitar don't get changed regularly, the bone will cause them to rust at their point of contact and also ruin the bone. To resolve the problem you could use stainless steel strings. However a thin 1/16" sliver of flat copper can be notched into the bone and supper glued in place under the B & E string to the top face of the saddle and nut, as workable solution.

Start by sanding the **Nut Blank** to fit squarely into its slot, its bottom face should sit absolutely flat on to the neck wood, hold the job up to a light to see if there are any gaps of light; lightly sand the bottom face edges away for a snug fit. Pencil mark the face of the nut exposed to the face end of the fret board and measure up a height of about the thickness of 2 x fret crowns. This will allow for enough height to notch the strings onto the nut. Once the nut is cut to size file its top face to give it a slight backward angle, towards the machine heads. Cut shallow notches onto the top curved face of the Nut to take the strings, using needle files. Glue the Nut down by applying glue only on the face that touches the end face of the fret board, and use the two outside strings with a little wound up pressure. Once the glue has set the notches in the Nut can be cut to the right depth, using the method described previously on page 5 of the ***String Scale Length***.

After setting the action on the Nut, file away any excess notch depth from the top face of the Nut; the notch depth should only be a little more than 1/2 to a full thickness of the string being set.

Making the Saddle takes on the same precautions said for making the Nut, but in particular with the saddle: it should sit absolutely flat but also be made able to slip in and out of the slot without any sticking.

Initially take some measurements, use an old plastic dummy saddle and tension up all the strings to concert pitch. Measure the action at the 12th fret for the low E string this should be just under 1/8", and 3/32" for the treble E string.

Check that the neck has pulled up by at least 1/32" as discussed in "The Fret Job". The neck however, should not take the entire load of the strings tension on its own; the truss rod needs to be tightened up just enough to be useful at holding the neck rigid against string vibration. **To avoid the risk of breaking the truss rod and or striping the thread, only tighten up the truss rod after the string tension has been loosened off.**

With the neck and truss rod properly set, we can then relook at the measurements to be taken for the action. If the measurements for the action of the two outside strings are less or more than what's needed as stated above, the saddle height can be easily worked out. It is really quite simple, by example: if say the action for the low E string is reading from the top of the 12th fret to under the string at say 1/32" above the required 1/8", then at the bridge saddle it will have to come down by 2x 1/32"= 1/16". Once you add or subtract the measurements required, to or from the depth of the dummy saddle, pencil-mark these measurements onto the face of the bone saddle. Then between the two pencil marks use a 12" radius template to pencil line a top curve onto the saddle. Keep the top edge face of the saddle flat after cutting it, for setting out the individual string compensation lengths.

Intonation: The required extra string length for each string is set out in Table 1 page 5, but the job is more accurately carried out by using the following method of Intonation. Slip a piece of 0.012” or 0.016” gauge steel string in between the flat top face of the saddle and string being set, ..