Chapter Twelve Aye

Installing Camac Levers

Camac levers have become very popular over the last few years here in the United States, so I decided to prepare a short guide describing the process and tools I use to install them.

First consideration; Can I use these on my harp?
Camac Levers will usually fit on harps that accommodate the other popular brands (Loveland, Truitt, etc). A table of offsets is provided below, indicating the length of harp neck wood needed below the bridge pin for a harp that I build, Strung with Savarez KF strings:

String	String Length (Inches)	Center of Bridge Pin to bottom corner of lever (Inches)
1	4.8	.82
3	5.9	.82
6	7.9	.85
10	11.0	1.02

13	13.7	1.10
17	18.3	1.54
20	22.7	1.7
24	28.5	1.9
27	32.5	1.9
31	37.7	2.0
34	41.6	2.0

It seems that Camac levers require less space for mounting room at the bass end than most other brands. *If you are retrofitting Camac Levers onto an existing harp*, there are two issues you may want to consider;

- Will the bridge pin holes need to be filled? Camac Levers come with factory threaded bridge pins that can be raised and lowered by screwing them in and out. Generally the bridge pins come in three different sizes, and the small and medium sized pins (H6, H7) require a holes that are smaller than the traditional 5/32 bridge pin used in many harps (see the table in section on drilling the neck). If you want to use the Camac factory bridge pins, you will usually need to fill and re-drill the bridge pin the holes for about 2/3 of the levers.
- Will the screw holes for the levers need to be filled? The screws for the Camac usually fall directly under the string. Loveland, L&H Performance and other levers have fasteners in the same place. You may need to fill the old lever holes to accurately place fasteners for the New Camac Levers.

Ordering the levers

You can order the levers by emailing the string specification (length, gauge and composition) to Camac. Most orders

seem to arrive to the U.S. In 4-6 weeks. A number of Canadian builders indicated that they have received the levers in about a week, so one would presume the delay has something to do with U.S. Customs!

Tools

There are a couple of specialized tools that can facilitate mounting these levers. Camac expects you to drill metric holes for the bridge pins. I could not find metric bits, but found that a set of numbered bits are entirely adequate to the task. The bridge pins can be driven with small metric socket wrenches, but purpose built drivers make the job much quicker and easier. The screws that Camac sends to hold the levers to the neck are interesting. They can be driven with a plain, flat blade screwdriver, or a T8 torx driver. The Torx driver does not require as much down pressure, won't slip out of the slot (and mar the finish on the neck), and can put a lot more torque on the screw. Luckily you can get all of these items from MSC

Item	MSC Stock #	Price
4mm nut Driver	84973734	$6.46
5mm nut Driver	84973759	$6.61
6mm nut Driver	84973775	$6.80
T8 Torx Driver	05059084	$3.65
Jobber Drill Bits, #1-60	01176601	$63.97

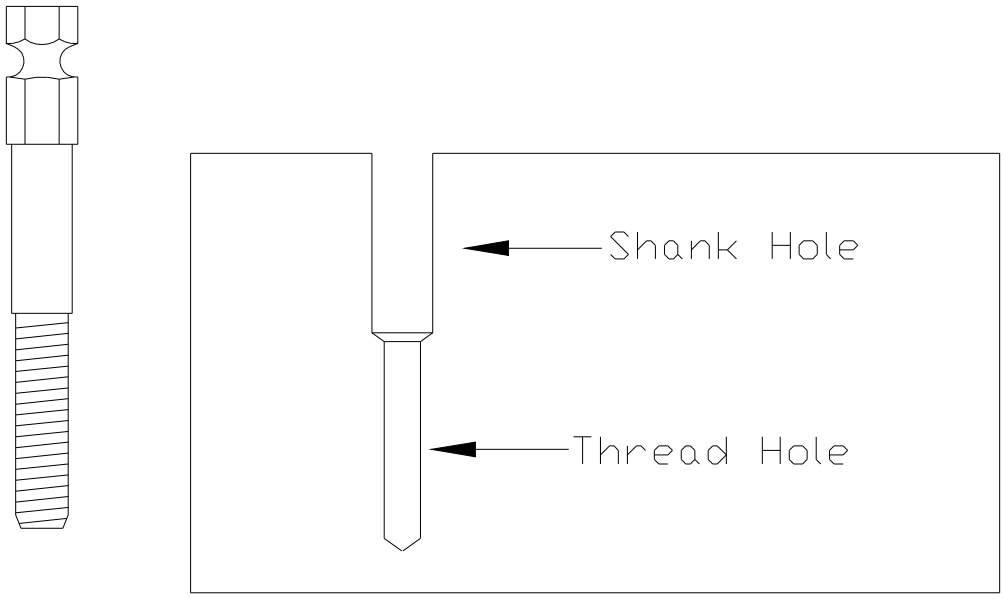
At $64, the Jobber bit set is not cheap. The set of bits run from .040" (#60) to .228" (#1), with a bit every .002-.006". I balked at the price initially, but once I had them, they

proved invaluable for many, many other common shop tasks. They are great for drilling precisely sized holes for eyelets. You can drill precise pilot holes for taps. You can fit small dowels, nails and pins with sliding or snug interference fits. Once you have them, you will wonder how you ever got along without them.

If you are selling the harp to a client that will need to regulate their own harp, you may want to provide them with a set of four drivers.

Drilling the neck

The holes in the neck for the bridge pins must be drilled in two steps, a hold for the flat shank of the pin and a smaller, deeper hole for the threaded portion.



I find the holes end up more concentric if I drill the deeper hole for the thread first. Then I let the larger bit for the shank center itself within smaller "pilot" hole. If you don't have an accurate, reliable depth stop that you can set on

your drill press, I would recommend you use a strip of tape around the drill bit to precisely control the depth of the holes. You want the shank hole and thread hole to be about an 1/8 " deeper than they are on the bridge pin. I know this because I have been halfway through levering and had a dozen pins prematurely bottom out as I tried to regulate the levers. It is a real pain to have to take off the string, unscrew the bridge pin, redrill the holes, and put everything back together.

You want the Shank hole to be the same size as the pin shank. For the threaded portion, I select bits that are .006-.008" under the major thread diameter for the medium (H6) and large (H7) pins. H6 and H7 pins are thick enough that one can safely apply considerable torque to drive them in. The smallest H5 pins are delicate. The pins appear to be made from some brass alloy, plated with nickel. I snapped one off, right between the shank and threaded section. There is no good way to remove the threaded section and it is *really* frustrating to have to leave a piece of metal in the neck, preventing you from placing the a second bridge pin right were it should be. For those of you without a micrometer or dial caliper, there are the sizes I use to drill the holes for the bridge pins in cherry:

Diameter and Depth Camac Bridge Pins

	Small (H5)	Medium (H6)	Large (H7)
Thread	#31 x 1"	#25 x 1.28"	#13 x 1.31"
Post	#25 x ½"	#12 x 0.65"	15/64 x 0.69"

If you are building a harp from Rock Maple, Wenge or other really hard wood, you may want to go up a size or two. The

best guide is to drill test holes in scrap and screw the pin all the way in. You want it to screw in with moderate resistance.

Camac usually sends a few extra bridge pins, and there may be some confusion as to how many H5, H6, and H7 pins should be used. If you carefully look at the base of the levers, you will find three different sizes. Small, medium and Large bridge pins correspond with a commensurately sized lever base. On most of my harps, the middle sized pins (H6) are used for strings 16-23 or so.

Driving three dozen pins into the neck can be a tedious work. I took a piece of 3/8" steel and ground the end to a square that would fit my 4, 5 and 6mm sockets. This allows me to use an electric drill to do most of the work. I am careful to stop the drill 1/8 inch or so before the hexagonal shoulder on each pin touches the neck.

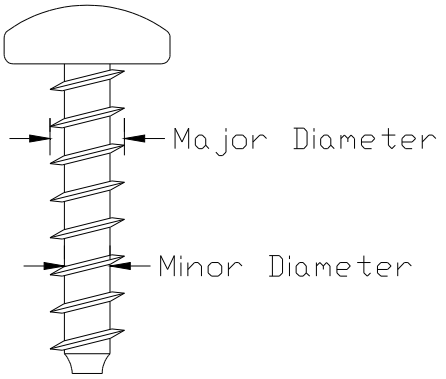
After the harp is built, finished and has been held to tune for a week or two, I mount the levers.

Mounting the levers

To determine their position, you will need to hold the Camac Levers in place with considerable force. This is impossible to do with the harp standing vertical. Lay the harp out flat on a table. You will need gather the following tools:

- Awl to precisely mark the centerpoints for the screws that attach the levers
- The 4,5,6 mm nut drivers

- The Torx Nut driver
- An accurate electronic tuner (I use a Korg CA-30)
- Two shop towels or rags to damp the strings
- Electric Drill



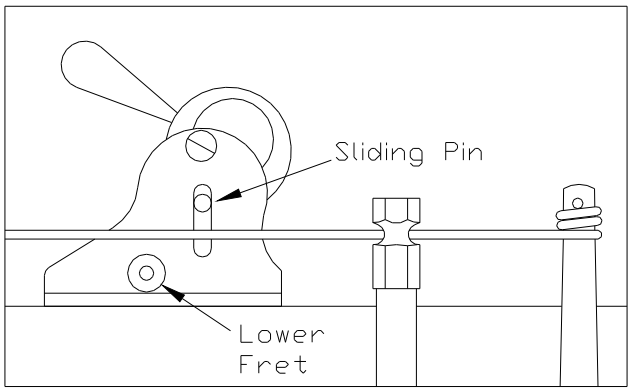
The drill bit to use for the screw holes is going to vary with the type of wood used in the harp's neck. If the harp neck is built of walnut or mahogany, I use a drill bit that is about .002" under the minor diameter of the screw. When I am working in a very hard woods like Wenge or Bubinga, I will select a bit that is .002 to .003" less than the major diameter.

If you have some scrap, test the bit you have selected. You want to be able to drive the screw all the way in with moderate pressure. If the hole is too large, the screw may strip out before it generates enough force to hold the lever firmly to the neck. If the hole is to small, the screw head may break off.

I use a small piece of tape wrapped around the bit to indicate when the hole is drilled deep enough for the screw.

I would suggest that you start mounting levers in the mid range the first time you mount Camac Levers. This is a fairly forgiving zone. At the treble end, space is constrained, and the a handful of levers at the top are different from the others in that they don't have a lower fret . At the bass end there is less room for error (the levers have to be placed

precisely), and the transition from heavy gauge monofilament strings to the wound strings introduce some complexities (more about this later). I find my tuner gives more decisive readings if I damp the strings that I am not working on by placing a rag over them.



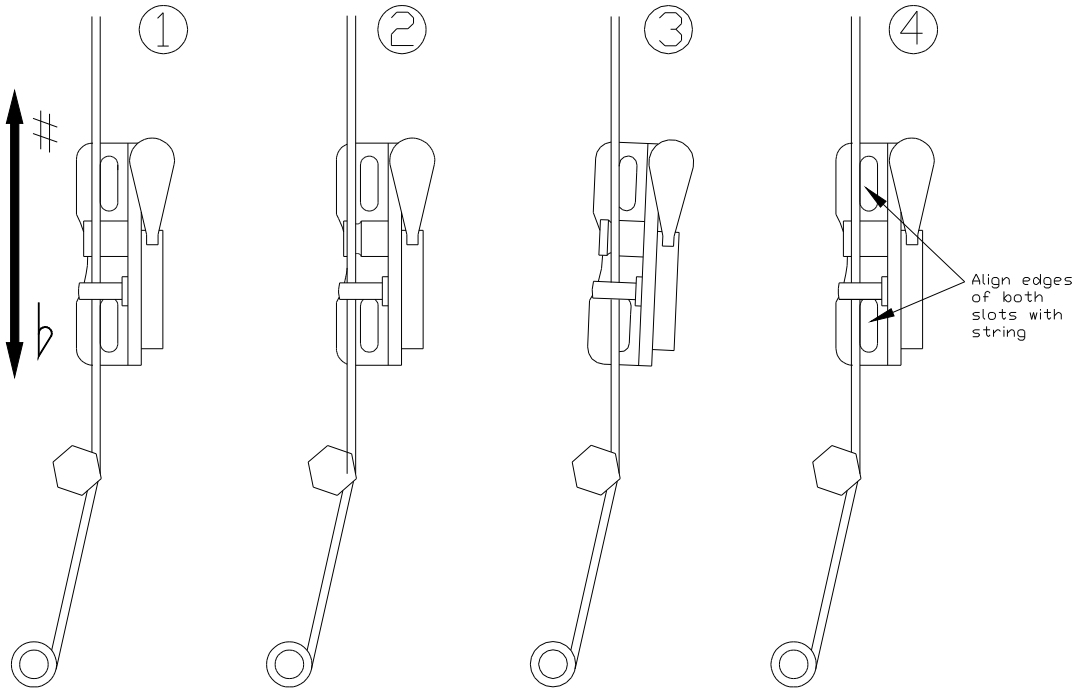
Most of the levers have this configuration when viewed from the side. Note that the string passes about halfway between the sliding pin and lower fret in this diagram. I refer to this as the *neutral position*. By twisting the bridge pin you can move the string so it is *high* (nearly touching the sliding pin) or *low* (nearly touching the lower fret. On the large body levers, the "adjustment space" from the low to the high position is about 4mm, depending on the thickness of the string.

In the mid-range I place the lever on the neck, about ½" below the bridge pin and adjust the bridge pin so the string is in the *neutral position*. Moving the bridge pin up or down will usually change pitch of the string. I don't usually worry about having each string at concert pitch while mounting the lever. The goal is to place the lever so it raises the string's pitch by one half step (exactly!) when it is engaged. After you are done you can retune and strings to concert pitch.

I pluck the first string with the lever disengaged and note the reading on the meter. It may be spot on, it may be 5 cents sharp. Let's say it is five cents sharp. I engage the

lever and pres firmly and pluck the string a second time. Let's say the tuner now reads a half step higher, but 10 cents sharp. The lever is supposed to raise the string's pitch exactly one half step, to 5 cents sharp (remember that initial reading!). The lever makes the string too sharp, so it needs to be moved up towards the bridge pin, effectively making the string longer, flattening the string. If the string were dead on, or five cents flat, I would move the lever away from the bridge pin. Most people rapidly develop a good feel for how far a lever should move, and can get it within 2-3 cents of a perfect half step.

After I am happy with a lever's position, I will check to make sure the groove in the lower fret is centered under the string and the string is running parallel to slots in the base.



Adjust the height of the string to the neutral position, then 1. Move the lever up and down to sharpen or flatten the intonation. Levers 2 and 3 will not engage or disengage quietly. Lever 2 is

pulling the string to side and needs to be moved to the left. 3. Check to see if the lever is skewed. 4. The slots should be aligned with the string. Check for all three positioning requirements before pricking the divots and drilling the screw holes in the neck.

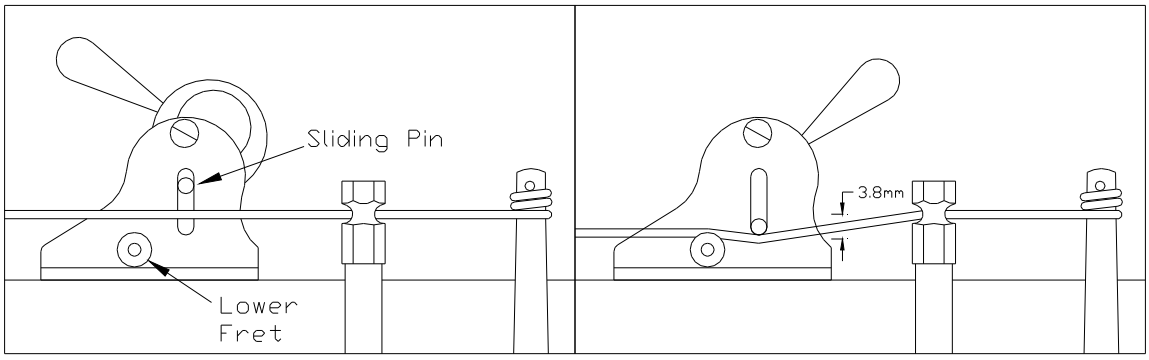
A good levering job is a precision game, less than half a millimeter. It pays to take your time and recheck the lever's position before marking and drilling holes. Carefully aligning the levers has cosmetic and acoustic benefits. Levers skewing to the right and left look like a mess. If a skew lever has to be shifted up or down to regulate the harp, it will "dink" when it is engaged or disengaged.

As you drill the hole, for the screws that attach the lever to the harp, you will have to tug the string to the left, towards the sound box so the drill bit does not nick the string. The bit may also have the tendency to flick to the right or left as it is pulled out of the hole. Nicks lead to breakage down the road so try to keep the strings pristine.

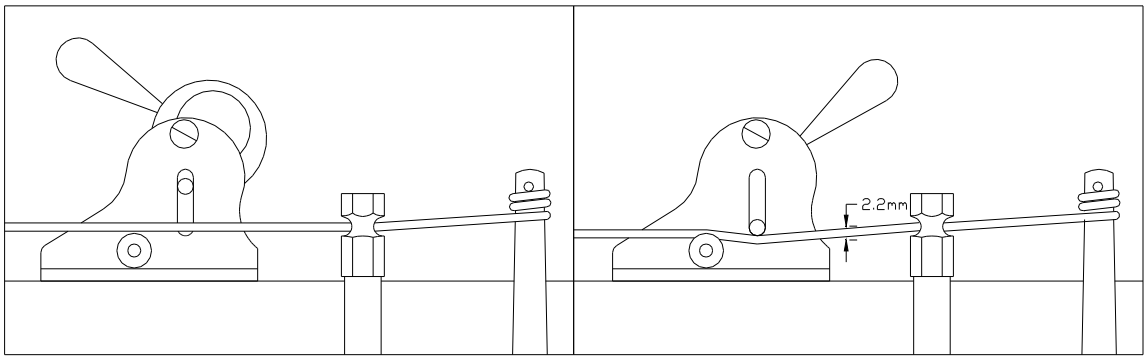
Screw the levers firmly to the neck. I put the screw on the end of the torx driver and hold the screw in place with my fingertip. With the other hand I position the lever while I press the tip of the screw down into the hole. Here again, I pull the string to the side to keep the threads and head of the screw abrading the strings. If you tighten the first screw all the way down, then back it off ¼ turn, it will hold the lever in place and you can use two hands to finagle the second screw into place.

After the screws are in place, I pluck the string with the lever engaged and then disengaged to check the intonation. Does the lever raise the pitch of the string exactly half a step? Even an experienced leverer will need to fine tune many of the strings. There are two effective ways to fine tune Camac levers;

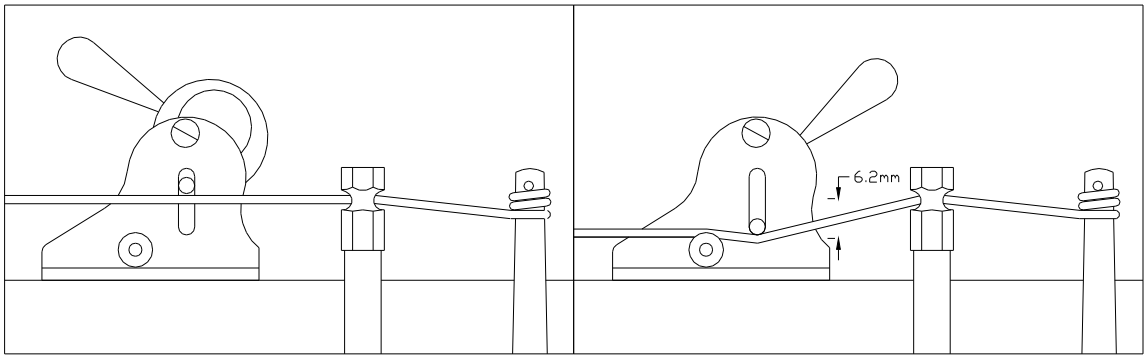
1). You can loosen the screws ¼ turn and shift the lever up and down on the neck
2. You can use the nut drivers to screw the bridge pin in or out.



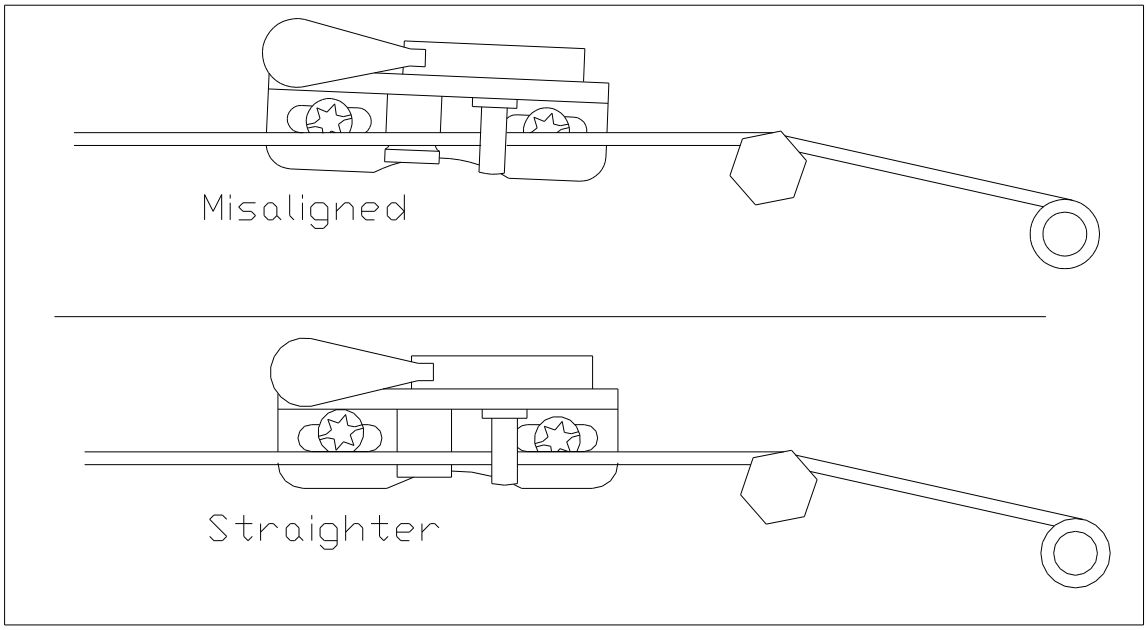
In the neutral position, the lever pushes the string down 3.8 mm as it is engaged



If you move the bridge pin to the low position, the lever only has to push the string down 2.2mm when it is engaged. Because the lever doesn't have to push the string as far, it won't raise the pitch as much as it does when the string is in a neutral or high position.



If you move the bridge pin to the high position, the lever has to push the string down 6.2mm. This will raise the pitch much more that it does when the bridge pin is left in a neutral or low position.



The screws holding the levers to the neck are narrower than the slots machined into the fret. They have a half a little bit of play. Small misalignments can frequently be corrected by disengaging the lever and loosening the screws. Push against the lever while each the screws are tightened. When you get to the smallest levers, you will find they don't have a lower fret. These levers have a groove in the sliding pin. When it is misaligned it will go "dink" too. The fix is the same.

Mount more levers towards the bass end. You will find that you can accurately forecast the appropriate spot for the next lever by placing it the same distance away from the bridge pin as the last lever.

Realize that bridge pin in an extremely high or low position are more likely to buzz, so try to improve your placement accuracy, so the string remains close to the neutral position and only need to make fine tuning adjustments with the bridge pin.

Levering Bass Strings

The sliding pin on the lever is trying to push the string down when the lever is engaged. As you come to the strings with 40 and 50 lbs of tension, you will have to push down quite forcefully with one hand to hold them firmly to the neck while plucking with the other. This is probably the toughest part of Camac levering. A few tips;

1. The upwards force of the string on an engaged lever will be less if you start with the string in a position a smidge closer to the low position from neutral.
2. I don't worry too much about skew and centering the string over the fret groove while the lever is engaged. I find the sweet spot where the lever is raising the string a half step, then finesse the right/left alignment with the lever disengaged.
3. Bass strings are long, and harmonics can make the indicator on the tuner dance around. Damping the

other strings and plucking the string at the middle will make the readings more consistent and accurate

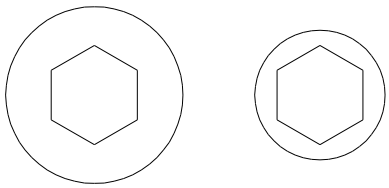
4. As you move from the monofilament to wound strings, there are significant changes in string diameter from string to string. At some point you will also transition from the medium lever bodies to the large size. Realize these discontinuities are coming up and it may break the nice even line of levers you have been laying down.

It is hard to get a nice sweeping line of levers on some string bands than others. Some builders simply put the levers where they work the best, damn the aesthetics. Others lay the levers down in a sweeping curve and hope they can use the bridge pin adjustment to get them regulated right without any buzzes. Dramatic changes in bridge pin height (from string to string) can distract some harpists.

Like so many other aspects of harp building, the real trick is striking a compromise that will balance all three demands.

Levering Treble Strings

The head on the 4mm nut driver is too large for the tight work around the treble levers. It takes ten minutes to grind away about 60% of the wall on the tip of the 4mm driver. Do this - the smaller head makes it a much more effective tool.



Schematic of the 4mm. driver, Head- on before and after grinding.

As you proceed to the very top string, you will find the levers moving progressively closer, towards their bridge pin. The levers that Camac sends for my harps not have a lower fret on the top five or six strings. At this point, the top four levers sit right next to the bridge pin and the next three will be within a 3-5mm of the bridge pin.

Without a lower fret to define a "neutral position" for the bridge pin, I switch to a different procedure for setting the initial bridge pin height. With the lever pushed all the way up against the bridge pin, I set the height of the string so the grooved (moving) barrel on the lever deflects the string down a millimeter as the lever is engaged. If the bridge pin is set too high, the string will pop the string out of its place on the bridge pin as the moving barrel descends.

To mark the divot for the holes on the top octave, I position the lever so it is butted up against (touching) the bridge pin. I mark the divot at the bottom of the slots in the base of the lever. When the lever is attached to the neck, it will just touch the bridge pin when it is shoved all the way up. It will 4-5mm away when it is pushed all the way down.

After these are mounted most of the adjustment is done by adjusting the height of the bridge pin. When the levers are touching the bridge pin, you won't be able to put the nut driver over the head, so you will have to loosen the base screws, and slide the lever back, then adjust the bridge pin. Slide the lever up and retighten the screws. Repeating it till

you get it right. It is not unusual to spend 80% of your time levering the top and bottom octaves.

Production levering

After I have levered two or three harps of the same model, and I am fairly happy with the position of the levers and elevation of the bridge pins, I will take notes and record the heights of the bridge pins, so that I can set them to that height before the harp is strung up. The notes will also help me with the trickier bits, so I don't have to rediscover them when I lever another Luchair a few weeks from now.

Yours notes are likely to vary.

Luchair 34 – Camac levers and Bridge Pins
September 9, 2008

Use a #46 bit (.081″) in Cherry, #41 (.096″) for

Bridge Pin Sizes	
1-10	Small
11-23	Medium
24-34	Large

Approximate Bridge Pin Heights		
1-6	.440″	
7-10	.470″	Lever #7 has first fixed Fret
11-15	.510″	#11 is the first medium Bridge pin
16-22	.550″	#16 is the first medium bodied lever
23	.605″	#23 is first Large Bridge Pin
24-26	.620″	#24 is first large bodied lever
27-34	.580″	#27 is first bass wire string

Set levers 1-4 by placing as close to the bridge pin as possible. Mark hole in slot as far from the bridge as possible. When attaching lever, put nut driver over bridge pin and push lever against the nut driver whilst tightening the screws.

Levers 5-18 follow the sweep of the harmonic curve closely

Bass Wires – The lever offsets from the bridge pin to the front edge of the Lever

27C	.60″
31F	.75″
34C	.95″