

World-Wide Technical Reference Guide

Tuning and Voicing



S T E I N W A Y & S O N S

Boston
PIANO
DESIGNED BY STEINWAY & SONS®

Essex PIANO™
DESIGNED BY STEINWAY & SONS

*the Family
Steinway
Designed
Pianos*

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TUNING

Background: Solid tuning is a must. Although there are numerous temperaments, Steinway maintains the A440 to A220 temperament. **In order to achieve a solid tuning it is important that the technician consistently use forte test blows with each strike of the key. Make sure the tuning hammer turns the tuning pin within the pinblock and that the tuning pin is at rest and stable before moving on.**

Steinway & Sons stresses the importance of aural tuning. Developing piano tone is a mechanical and musical art. Solid aural tuning exercises and develops the musical ear, giving the technician a greater ability to master the methods used in tone building.

Hints: All 4ths are wide from perfect intervals.
All 5ths are slightly narrow from perfect intervals.
All Major 3rds are wide from perfect intervals.
All Major 6ths are wide from perfect intervals.
Major 3rds and Major 6ths should accelerate when moving chromatically up the scale, and decelerate when moving down the scale.

Step 1. Temperament Tuning

- A) Tune A440 to A440 fork.
- B) Tune A440 down to A220. (wide octave interval)
- C) Tune A220 up to E. (narrow 5th interval)
- D) Tune E down to B. (wide 4th interval)
- E) Tune B up to F#. (narrow 5th interval)
Check M6th, A to F#.
- F) Tune F# down to C#. (wide 4th interval)
Check M3rd, A to C# < M6th, A to F#.
- G) Tune C# up to G#. (narrow 5th interval)
Check M6th, A to F# < M6th, B to G#.
Check following intervals for even and consistently faster speed progression: M3rd, A to C# < M6th, A to F# < M6th, B to G# < M3rd, E to G#.
- H) Tune G# down to D#. (wide 4th interval)
Check M3rd, A to C# < M3rd, B to D#.

- I)** Tune D# down to A#. (wide 4th interval)
- J)** Tune A# up to F. (narrow 5th interval)
Check M3rd, A to C# < M3rd, C# to F < M3rd, F to A.
- K)** Tune F down to C (wide 4th interval)
Check M3rd, C to E < M3rd, C# to F.
Check M6th, B to G# < M6th, C to A.
- L)** Tune C up to G. (narrow 5th interval)
Check M6th, A to F# < M6th, A# to G < M6th, B to G# < M6th, C to A.
Check for fit in relation to previously tuned M3rds.
- M)** Tune G down to D. (wide 4th interval)
Check for fit in relation to previously tuned M3rds and M6ths.
- N)** Check D up to A. (narrow 5th interval)
Check all M3rds and all M6ths.
Check all 4ths.
Check all 5ths.

Step 2. Octave Tuning

NOTE: All octaves should be stretched to some degree. In the treble, stretch the octaves favoring progressively faster intervals of 10ths and 17ths, while keeping the 5ths virtually beatless.

It should be noted that the ear generally tends to prefer hearing the treble sharp, and the bass flat.

Hint: To illustrate this point, try this easy exercise:

Play a major chord in the tenor area of the piano to give a mid-range sound. Without using the aid of interval tests, tune consecutive octave notes using **only** the initial mid-range chord as an aural guide. After completing all the octaves in the scale, compare your memory tuning to interval tests. You will most likely observe the tendency to tune sharp.

Strive to balance between the tendencies for more aurally correct treble and bass settings and their relation to interval tests.

Concert Tuning Techniques from Hamburg

Preparation for Tuning

Check strings for discoloration/corrosion and clean with a pad (like Scotch-Brite or steel wool) or light benzene in order to minimize the occurrence of false beats.

Check strings at bridge pins and carefully tap down if necessary (also to minimize the occurrence of false beats). Strings could also be slightly stretched with the use of a small wooden stick for the same purpose, however this action should never be carried out shortly before the concert starts, but only hours/days before, because the string will become somewhat restless and unstable in pitch.

Check the pitch of the instrument. If it is more than 1 Hz different from the desired pitch you should decide to do two tunings: the first one to the necessary pitch very quickly and if time allows the second one later after some rest time. If no rest time is available, then this fine tuning must of course be done at once.

If you don't know the instrument and have to tune it for the first time, it is advisable to carry out two tunings in order to move and settle the tuning pins according to your technique and achieve a good tuning stability! The instrument might have been tuned with a different technique before so that one tuning alone as a matter of course won't always work, but rather destabilize the tuning pins and strings.

Tuning Technique

The tuning lever should sit at approximately 2 o'clock on the tuning pin, or near as possible to parallel with the strings. If it were at a position parallel to the pinblock like approximately 3 o'clock, the tuning pin would rather be bent towards the tuner with the disadvantage that the tension of the string would later pull the tuning pin back into its position of equilibrium with the string going out of tune.

The lever should sit tightly on the tuning pin and is not supposed to have any side play. This ensures that the movement of the tuning pin can be felt much better and the best force/leverage transmission is guaranteed.

The pins should always be turned/rotated in the holes, and not bent, in order to prevent the pins from bending back later and the strings going out of tune.

The pins should only be moved as little as possible! Even if the pitch is far under, the string should only be tuned slightly above the desired pitch and then down to pitch! Moving and thus stretching the strings a lot will destabilize the tuning.

It is necessary and advisable to use a strong stroke/touch in forte/fortissimo! Good listening starts with mezzo forte anyway and through the use of force the string will best glide over all contact/friction points like agraffes, V-bar, bridges, and duplex scale! By doing this all string tension

in the various areas will be equal, which guarantees a stable tuning. Using pianissimo strokes will likely lead into different tensions in the string sections, which will even out themselves automatically later, but leaving the string out of tune. As pianists will use fortissimo, the tuning should be carried out under a similar force as well.

Warning: Loud tuning can damage your ears; reasonable ear protection which lowers decibels is available and should therefore be considered an appropriate protection for your health!

The hard stroke should only be used shortly before reaching the desired pitch, and not if the frequency is still far away! By keeping this in mind you don't have to use loud strokes all the time, which prevents one from getting tired early.

The same force should be used for all strings in a unison, in order to stabilize the strings evenly.

The Tuning

After adjusting pitch and doing the temperament including the relevant unisons, it is advisable first to do the octaves down to the end of the middle section and up to the last treble note. Always tune the unisons right away (and not only just one octave string), because a completed unison will serve as a defined reference tone for the next octave and as a control tone for thirds, fourths, fifths and sixths! Single strings could go out of tune during the progress of the tuning and would serve as a wrong reference, and the tuner would recognize this only later when the work is almost done.

The bass of the instrument can be tuned in the end; however, it wouldn't do any harm if it were tuned earlier after the middle section, because one should not expect large bass bridge movements and hence strings going out of tune again in other areas because of this.

It is advisable to stretch octaves in the treble, which accommodates the hearing of human beings. Additionally, in large concert halls the stretching compensates for the sound delay caused by air movement and listeners will have the impression of perfect octaves.

Tuning Tests

Middle and treble sections should be tested with octaves/double-octaves, tenths and double-tenths.

The bass should be controlled with tenths/double-tenths. Additionally, fifths and thirds serve well for testing, as the intervals can be heard easily in this area.

From bass to treble the "rolling" of tenths/double-tenths should be getting evenly faster (treble) or slower (bass).

With various chords it should be tested to hear whether the sound "stands"; a wrong tuning will make the sound unstable.

By using forte blows the tuning stability of unisons can be tested.

General Hints:

The third string in a unison should always be tuned without a felt mute (without dampening any string) in order to hear all strings together and be able to define a perfect unison!

In big halls and under noisy circumstances when hearing the instrument is difficult, using the protective cover of the instrument could serve to improve hearing while tuning. Just simply put the cover on the piano and open the top lid to its highest position. The cover will still hang over the rim mostly and will keep the sound like in a cave—much better to hear than without!

Felt mutes are preferred in contrast to rubber mutes, because they dampen better and will not move out of the strings while using forte blows. (Rubber glides out.) Rubber mutes can give irritating sounds, too.

For the middle section, a long, thick and firm felt strip can be used to dampen the left and right strings of each unison.

VOICING TECHNIQUES

This section will address the proper voicing techniques for New York Steinway, Hamburg Steinway, Boston and Essex pianos.

Background: Voicing the piano gives the greatest opportunity for the technician to become creative. Although voicing is not measurable, every instrument should be balanced and melodic, and have variety of color. Various power ranges should be available to the musician throughout the keyboard, blending through the bass, middle and treble scales.

It is important that the technician become familiar with the needs of the musician and be able to make assessments in determining what characteristics each individual piano exhibits. Each piano will have a different range in color and power. Bringing the piano to its peak, without going over the edge normally produces the best results.

Adhering to the following procedures will be helpful; however, both experience and a conservative approach is necessary in achieving good results.

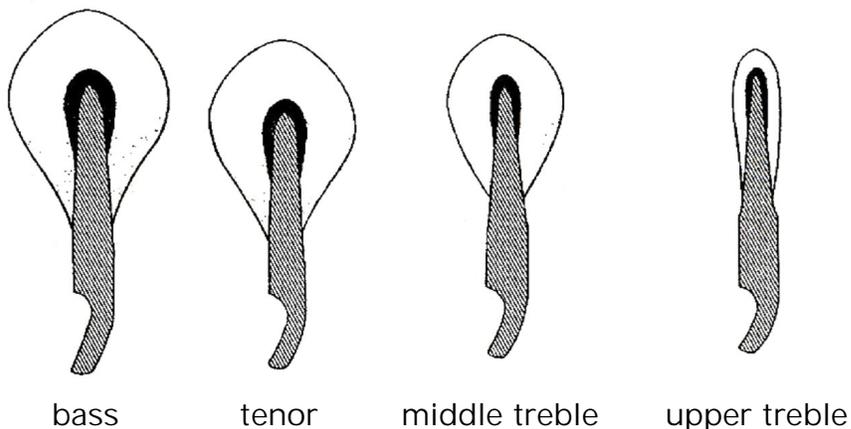
Before beginning to voice the hammer, the instrument must be well in tune, the action must be free from friction, and well regulated, and the keyboard must be properly eased.

Steinway New York Hammers

Step 1. File hammers—Filing hammers is necessary to restore and develop their proper shape.

Generally, the Steinway hammer should have a relatively narrow shoulder, uniform symmetry with a narrowed and slightly pointed strike point. It is very important to file the hammer so that the crown, is straight and horizontal. Filing also alters the regulation of the action, therefore all points of action regulation should be checked and adjusted as necessary.

hammer shapes for Grands (all models)

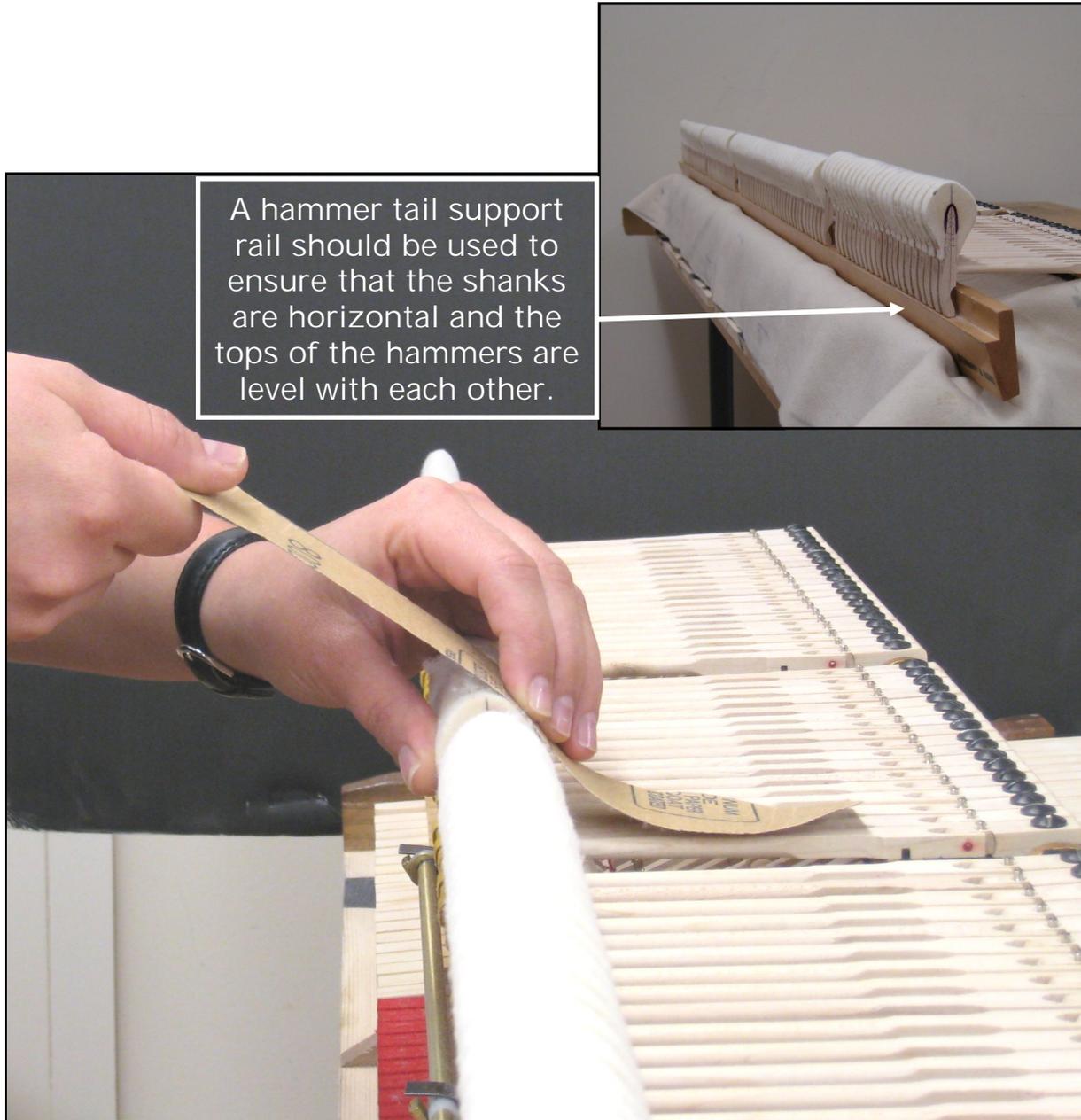


Stick filing—Stick filing is the most widely used method in building the shape of the hammer. Normally an 80-grit sandpaper is glued onto a wooden stick to make the hammer file. Each hammer is filed, starting well down on the shoulder with strokes upward from the hammershank, towards the strike point. Repeat this with 120-grit sandpaper on the backside of the hammer and finish off the strike point last, from front to back. The results should be a smooth, not fuzzy, surface.



Hint: For the straight-bored hammers in the treble, filing two adjacent hammers simultaneously helps to keep the filing stick parallel with the surface of the hammers.

Strip filing—Strip filing is also an accepted technique. Usually a cloth-backed 80-grit sandpaper is used. Use a narrow strip when shaping the angled hammers so the shoulders remain perpendicular to the hammer molding. Wider strips can be used in the treble area as the angle of the hammer approaches 90 degrees. The strip is used by pulling it with one hand while the other hand applies pressure on the area of the hammer which needs shaping. Follow up with a 120-grit of cloth-backed sandpaper to smooth the hammer surface. Take extreme caution in preventing the crown or strike point in becoming rounded, which will result in a poor hammer fit to the string. This is particularly important on the last hammer in each section due to lack of an adjacent hammer that maintains the evenly sanded surface.



Step 2. Fitting Hammers to the Strings

Background: Fitting the hammers to the strings is important in developing a clear, bell-like tone. The hammer **must** strike the individual strings of each note uniformly. Improper hammer fitting will result in unclear, distorted tones while at the same time reducing the overall power.

A) Block individual hammers to strings—With your finger, apply upward pressure on the fly tender. As the tender is pressed against the let-off button, the hammer will block against the strings. Let-off must be correctly set for this procedure to work properly. Hammers can also be lifted with a hook under the shank but care must be taken to lift straight up and without excessive pressure against the strings.



middle string too low



middle string corrected

B) Test hammer for fit—With the damper off the string and while the hammer is blocked (use sostenuto pedal), pluck each string to check for any “open” ones. If there is an open string, determine if the string needs to be leveled or if the hammer’s strike point needs to be filed. If the hammer has been correctly filed, the strings will most likely need to be leveled.

C) Level strings if necessary—Using a string hook, level the bichords or trichords by pulling up those strings which are the lowest. This must be done without creating kinks in the wire. This leveling will allow the hammer to contact those strings which were not previously muted, or blocked, by the hammer. Retune the string and recheck for hammer fit. Repeat as necessary until all strings within the note are fully “blocked” when the hammer is lifted.



D) Correct unlevelled hammers—If the strings are level, correct any open string condition by making note which portion of the hammer strike point needs to be reduced in height. File the hammer strike point, re-leveling it to fit the strings. Remember to maintain the overall shape of the hammer without widening the crucial strike point of the hammer.

Step 3. Test Piano for Power

Background: Building power—In order to achieve this goal one must understand that the New York-style Steinway hammer is somewhat softer than the common hard-pressed hammer when removed from the hammer press. Adding reinforcing solutions into the hammer has been a documented procedure that dates as far back as the 1880s when the first “hammer reinforcement” was added to the Steinway hammer. In 1880, the reinforcement was hot animal-hide glue. In the late 1890s and through the 1920s, shellac was used. Since 1930 the common agent has been clear lacquer.

HOW: **With hard test blows**—play notes within each section of the piano. Determine if more power is needed. Choose the weak regions in the scale and mark the keyboard where hardening solution should be applied.

Check for correct strikepoint of hammers—Shift the keyboard inward, and outward (changing the strikepoint) while playing notes. Aurally, determine the desired placement of keyboard and make adjustments on the brass keyblock plates if necessary. If the keyboard is relocated, recheck position of the sostenuto rod.

Step 4. Apply Lacquer

Background: Since a combination of lacquer and lacquer thinner is mainly used, in and outside of the Steinway factory, we will be discussing the application of lacquer. The factory applies a lacquer thinner and lacquer solution mixture of approximately 4:1 by volume.

New York Steinway & Sons hammers are designed to use lacquer as a stiffening agent, the time-tested method by which tone is built. We use **water-white nitrocellulose lacquer**, in a proportion of four parts of lacquer thinner to one part of lacquer. It is important that the hammer receive adequate penetration of the shoulders and core. A hesitant initial application will leave the core unsupported. Such applications will create a hollow shell both in fact and aurally, and block successive applications of lacquer.

The top tenor and treble sections will generally require full penetration. Experience and the requirements of the piano will dictate the degree to which lacquer is used at the crown in the lower tenor and bass sections.

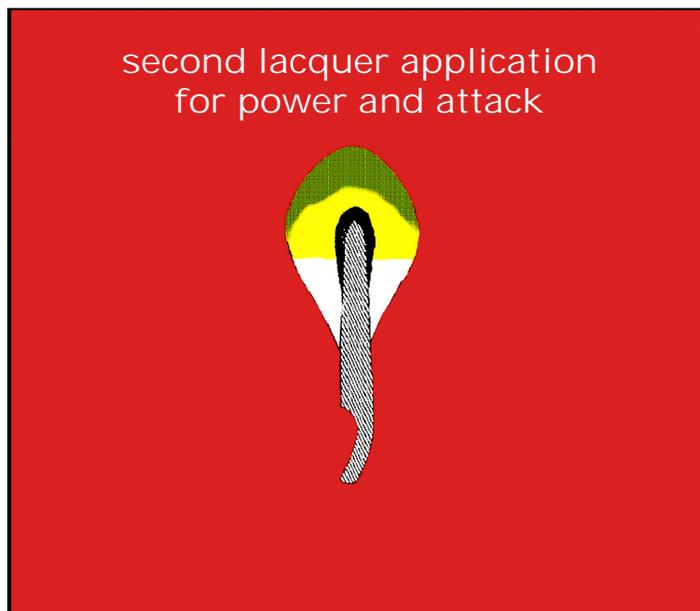
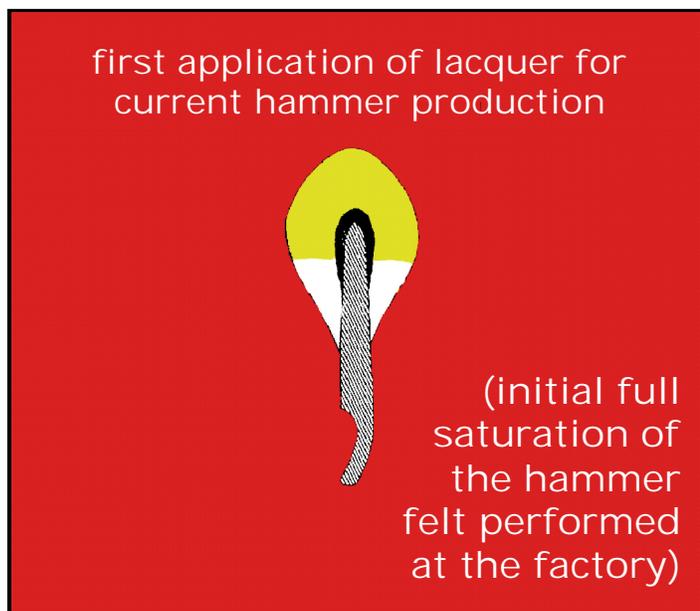
A Note on Lacquer Ratios: The ratio of solids content in the lacquer is the basis by which you determine the mix of lacquer to lacquer thinner. It is the solids content in the lacquer that remains in the felt to build the desired tone. The traditional amount of solids in the lacquer used for voicing New York Steinway hammers is approximately 12% thus requiring a mix with 3-4 parts of lacquer thinner (note: acetone works as a viable alternative thinner). Therefore, if you have locally purchased a nitrocellulose lacquer with 25% solids, you would alter your lacquer thinner / lacquer ratio to 8:1 thus re-establishing the correct amount of lacquer solids that would remain in the hammers as the tone-building agent. With this in mind, it is easy to calculate the proper ratios of lacquer / lacquer thinner mix based on the solids content of the lacquer you are applying.

As power is built, so is noise, i.e. a disproportionate distribution of energy to the upper partials. The reduction of noise is accomplished with very careful leveling of strings and mating of hammers to strings. Then, listening to individual strings and using a single needle precisely at the point of contact with that string, you will retain the power of the note and reduce noise.

The effects of the needle radiate from the needle minimally with a lacquered hammer. This makes the effects predictable and also requires an accurate placement of the needle as an integral part of your voicing technique.

Lacquer Application on New Hammers

- Install the hammers, file as needed, and listen to the overall tone.
- The hammer is then thoroughly saturated with lacquer and allowed to set overnight or a minimum of 6–8 hours. (Note that beginning First Quarter 2006, the New York Steinway Parts Department began shipping hammers with this initial lacquer application applied from the factory.)
- Reinstall the action and assess the overall tone.
- Apply to the area in the diagram to the right if a second application is required. A second application is not uncommon. Let dry for a minimum of 4–6 hours.



- Evaluate the tone and apply as needed to the area shown. Most commonly, this will be in the upper treble sections of the hammers but each hammer set will dictate its own criteria for applications of lacquer.

second lacquer application for power when attack is correct



Step 5. Allow the hammer solution ample time to dry overnight.

Acetone and Keytop Application

If the tone still needs more presence after the hammer has been reinforced with lacquer, three drops of keytop and acetone can be applied to the crown. This is a final step and not a substitute for the lacquer solution. Wait for 10–15 minutes after applying the keytop application and pound the hammers against the strings a few times each. This will work the solution in to the hammer felt and minimize the “sizzle” that traditionally results from this application. Be sure to work the *una corda* pedal so that the pounding is spread evenly across the striking surface of the hammer.

acetone and keytop mixture for attack



Steinway recommends 1 keytop per 8 ounces of acetone. Prior to use, the solution should set overnight to ensure that the keytop has thoroughly dissolved.

Step 6. Re-evaluate power—Again, use forte test blows and evaluate the power within the instrument. Lacquer most likely has been absorbed into the crown. This will cause “noise” during the forte test blows. At this point it is important to differentiate between overall “power” and “noise.” Do not be concerned with the “noise” at this time. The “noise” will be dealt with later through needling. Decide if more power is needed and where. Apply another application of lacquer solution, if needed.

Step 7. Begin Final Voicing through Needling Techniques

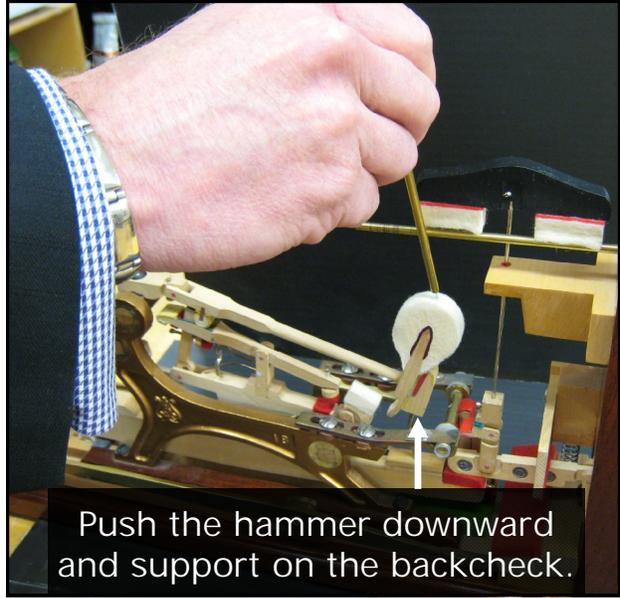
Background: After the lacquering operations, the piano can be described as powerful and noisy. The goal of the final voicing is to remove the noise, through needling, while retaining the power.

HOW: Remember, the final goal is to remove the noise while retaining the power. This is achieved by using the following guidelines:

Maximum needle placement—deep needling directly into the area of the hammer where the lacquer solution has been applied (crown and/or shoulders).

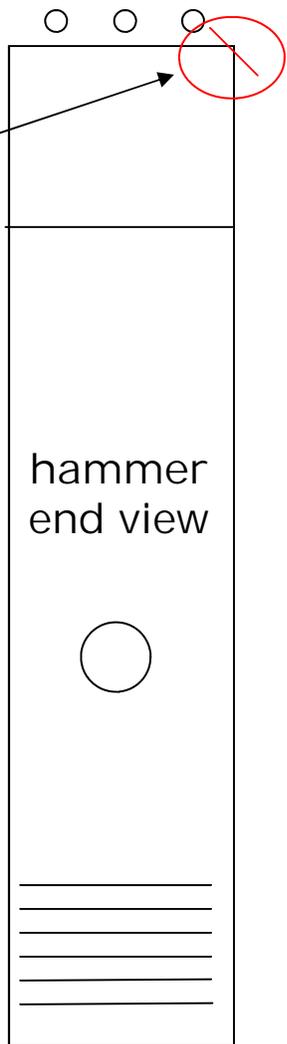
Minimum number of needles—If the hammer has lacquer noise, it must be needled on the strike point. Use **one** needle in the string grooves, and deep needle those strings which are creating the most noise. (Use a tuning mute and hard test blows to determine which strings in the note are noisy.)





Note: Single needling through the strings (chopstick voicing) can be a fast, effective way to touch up individual hammer voicing on the strike point. (See photos above.)

VERY lightly break the bass-side corner where circled on the trichord hammers to provide better una-corda tone on a full shift.



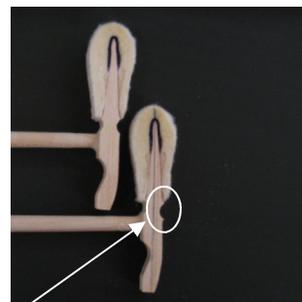
Step 8. Break left corner—With very light stick filing, gently “break” the sharp, left-side corner of the hammer. This will allow the hammer to easily clear the left string when the shift pedal is applied and minimize noise on the left edge of the hammer when the *una corda* is used.

Step 9. Check soft pedal shift—At this time make sure that the soft pedal shift clears the left string of the trichords. Adjust shift screw as needed.

Hint: If a full shift is desired, the hammer’s surface will have 5 individual string grooves: 3 grooves for the hammer in its normal position and 2 grooves for the hammer in its shifted position.

Step 10. Clean hammer surface—Using a fine grade, cloth-backed sanding strip, hammers should be lightly strip-filed to remove any chalk, graphite or needle marks. Then, hammers can be brushed with a fine, short-bristled wire brush which will remove felt particles and restore a cosmetically polished hammer surface. Listen again to ensure that the tone has not changed due to this brushing.

Step 11. Thin hammer molding in treble—If a woody tone is present in the high treble (approximately upper 6 notes), reduce the hammer mass by removing a small amount of wood from the hammer molding. Use a rounded wood file.



OTHER VOICING SUGGESTIONS

Hint: It is suggested that initial passes of “bulk needling” be performed, bringing down the extremes.



Hint: Try needling the hammer in the shifted position first, as crown needling the “shifted” string grooves will have some effect on the voicing in the normal playing position.

Hint: Use carbon paper to mark the string/hammer contact position. Place the paper **carbon-side-up** as shown, slide the action in and play groups of keys. Carbon will transfer to the strings. Take out the paper and play keys with action in rest position, very lightly marking hammers: then with action removed, clean strings with soft cloth and dampers raised to prevent damage to the felts.



Hint: Needling should be approached with voicing the loudest notes first, with each pass. Then, repeat passes until the tone is even and free from distortion. Do not attempt to even out the voicing with a minimal amount of passes.

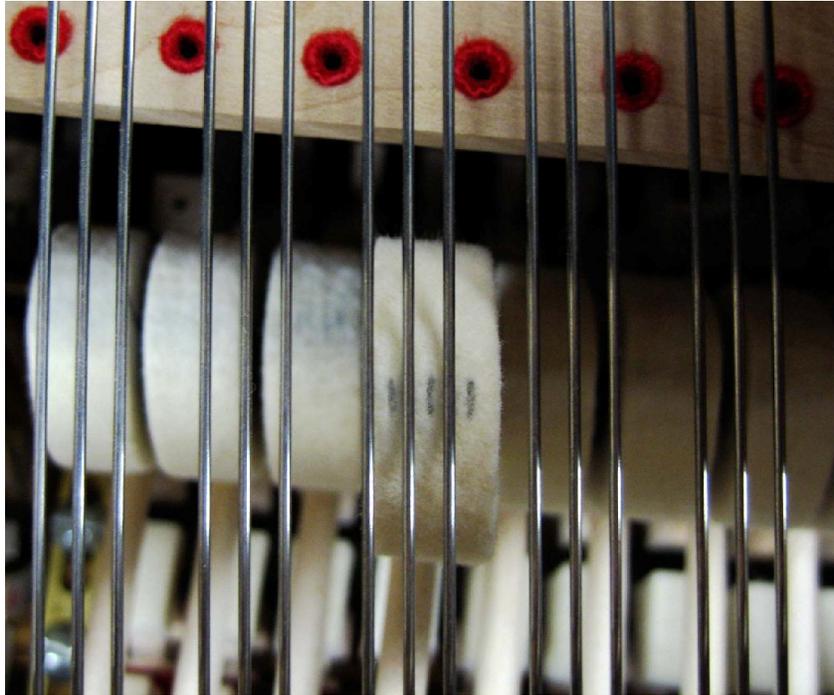
Alternate Regulation of Hammer Spacing

The traditional factory specification for spacing hammers to strings in New York Steinway grands has placed the hammer so that when it is blocked against the strings with the action in the rest position, about a string's width of felt is visible on the bass or left side of the hammer. This allowed for the hammer to shift in the *una corda* or shift position so as to miss the third string and alter the volume and timbre of the sound.

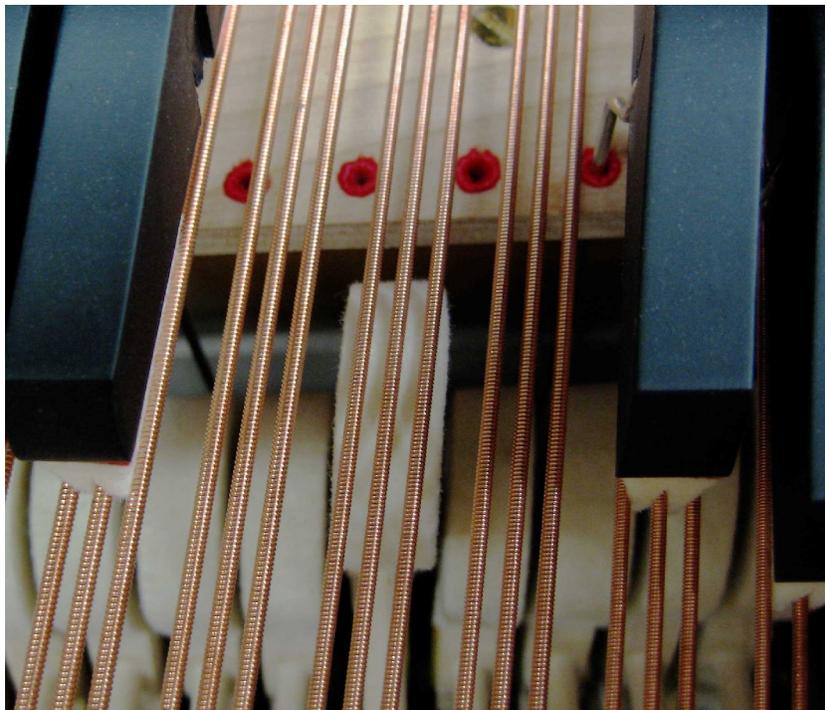
An alternate spacing used in many concert instruments places the hammer slightly more to the left, approaching being centered under the strings.



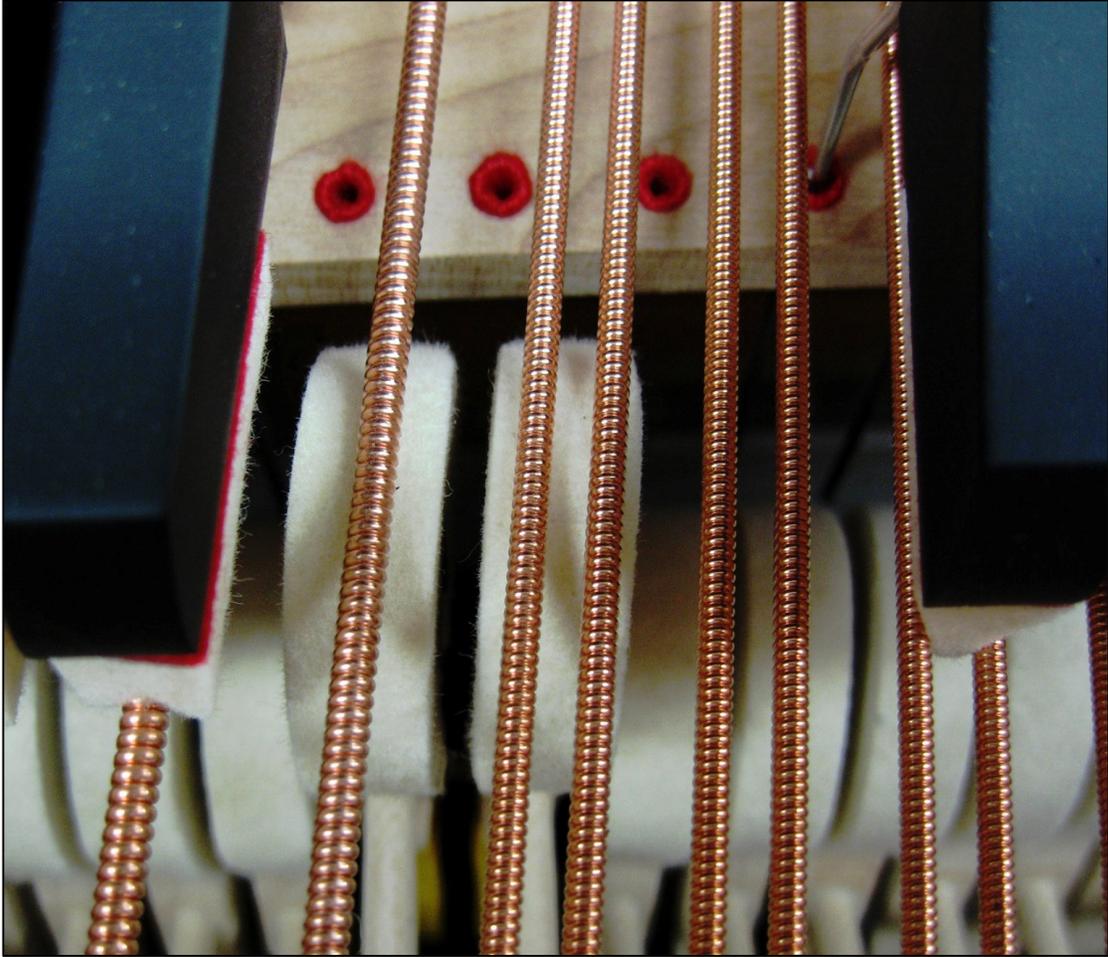
In the shift position the third string is still struck. The change of timbre and volume is produced by the way in which the hammer is voiced in that part of the hammer that strikes the strings. Regulation of the shift pedal is set to move the hammer to strike the strings in different felt.



A transfer mark of string/hammer contact made in the rest position will move just past centering between the strings of a trichord.



The hammers of the bass trichords can be regulated in the same way.



There is no change in the bass hammer spacing from the traditional methods.

Regulating the shift and the spacing in this way allows for very shallow needling in the felt between the strings without affecting either timbre or volume in the rest position. This can be done because of shallow needling and because the hammers allow very careful needling which does not affect the felt very far beyond the needle.

Hamburg Voicing Techniques

Steinway Hamburg uses considerably different hammer felts for the creation of the Steinway tone compared to Steinway New York. Whereas the latter felts are rather soft and require the building up of the tone by means of applying lacquer, the Hamburg hammers usually need extensive needling of the compressed felt in order to reduce hardness and achieve elasticity in the felt!

The Hamburg voicing procedure is separated into two steps—pre-voicing and final voicing—with the final action regulation in between.

Step 1. Pre-Voicing:

Before starting with the work it is a must that the action is well-regulated (during first action regulation) and the instrument is in tune! Prior to tuning, all unisons must be perfectly levelled at the agraffes by means of a string hook. This work is very important, because it will ensure a perfect fitting of hammers to strings later. Finally, all strings should be seated carefully at the bridge pins before starting to tune.

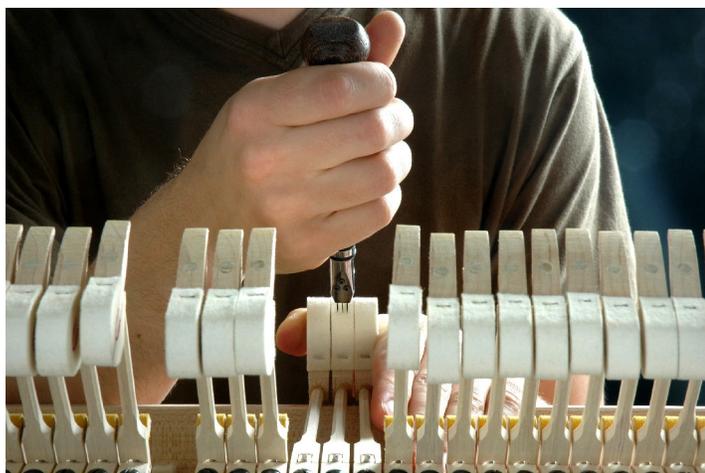
The voicing procedure begins by first playing the instrument in all sections (bass, middle, treble) with pianissimo to fortissimo strokes in order to get an overall impression of the tone and the character/firmness of the hammer felt. (The density of the felt can vary from set to set, making individual treatment/voicing of the felt necessary!) Both treble sections must be played as well and the keyframe (with the action stack on) carefully moved in and out at the same time in order to determine the best striking position (strikepoint) for the hammers.

Keyblock Plate Adjustment

Accordingly, the keyblock plate must be adjusted in the treble keyblock, which fixes the position of the keyframe on the keybed and thus the strikepoint of the hammers. (See photo.)



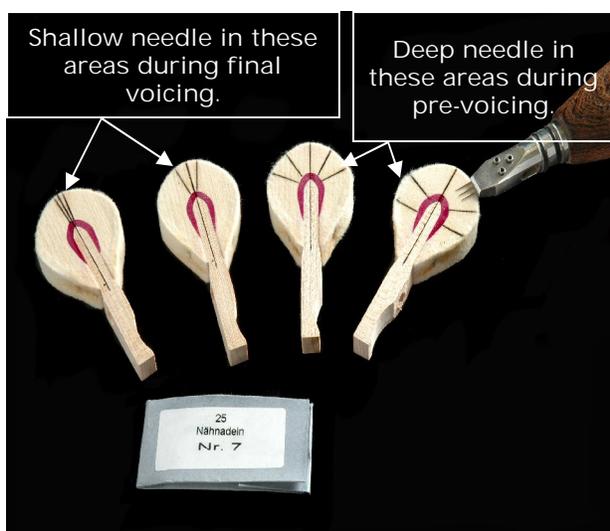
Now sample hammers must be chosen in each section, and both shoulders of these hammers needled, starting to stitch as low as just above the staple and going up to the top of the hammer, leaving approximately 5–7 mm of the striking area (depending upon whether bass or treble hammers are in work) untouched. For this purpose the keyboard with action needs to be placed on a workbench and the sample hammers supported by hardwood hammer rails. (See photo to the right.)



Note: The sample hammer and the two left and right adjacent hammers must be firmly held together while voicing (see photo above); this supplies additional support against the force of the needles. Never take more than 3 hammers at a time, because this would bend and thus damage the center pinning and bushings of the hammershank flanges.

Deep radial needling into the direction of the hammer core is required, the needles sticking out of the tool some 8 mm as shown in the photo on the right. The hammer felt must be treated evenly on both sides (shoulders) in order to achieve a balanced result. Listen to these samples and try to determine the reaction of the felt. It should obviously be a big difference in tone depth. The needling should produce elasticity in the felt and the hammer felt shouldn't lose its tension, either.

Note: The Hamburg hammer felt usually consists of long-fiber material under tension. If the felt is needled the fibers will shift upwards to the striking point in most cases, increasing the density there. So the needling can gain power and brilliance for the tone while increasing the elasticity for more dynamics at the same time! The more elastic the felt is, the more dynamically variable the tone will be.



If the samples produce the desired sound, all of the hammers in between can then be voiced accordingly. It should be done by section (bass, middle, treble). Inexperienced technicians can count the number of stitches per hammer shoulder necessary in the samples and duplicate this for every hammer in the section in order to achieve an even result. Experienced technicians will feel the resistance of the felt and the changes in elasticity, and needle accordingly without counting the stitches.

After all hammers have been treated, action and keyboard must be adjusted back into the grand and all notes played and checked accordingly to hear whether the desired sound level has been achieved. If certain notes or sections don't fit to the level, they must be reworked individually. Mark these notes on the corresponding keys with chalk and needle them while having the keyboard and action on your lap. Support the hammers with the voicing rail or block.



The next step will be the filing of the hammer felts. Please follow all instructions laid out for the New York hammers. The hammer shape and the techniques are identical between New York and Hamburg. The Hamburg felt should be sanded twice, first with an 80-grit rough paper, and afterwards with 180-grit paper. Fitting hammers to strings will be the next work to do. Follow the instructions for the New York hammers. This work is identical as well! The result should be as perfect as possible, because open strings have a negative impact on tone development.



Afterwards, all notes should be played again and differences in power and brilliance evened out by additional voicing. Listen to individual strings per unison as well and mark desired changes on the keys with chalk. Single-string needling is required now in order to achieve an even result within the unison and among all notes. Remember only to scarcely work the striking area while voicing; only shallow needling is allowed. By doing this a firm, dense felt "wedge" remains on top of the hammer, which moves on the elastic shoulders. Playing pianissimo should produce a clear tone, which won't become harsh while playing fortissimo. The tone should vary dynamically.

After every voicing of the hammers, always clean up the felt with fine sandpaper, preferably with used 180-grit paper. The striking area must be as clean as possible in order to produce a clean tone. Needling will change the felt, make the fibers stand up and influence the tone.

If certain sections, like usually the upper treble or low bass, don't really reach the desired tone level/power through voicing, individual hardening/"juicing" of the felts may be necessary. A thin Zapon lacquer solution (for example, a 10:1 solution of thinner to lacquer) applied to striking area and shoulders will help to build up tone. Make sure to use a thin solution, even if the juicing has to be repeated until reaching the level. A thick solution can prevent from further needling, making it impossible to insert needles into the felt. After juicing allow an overnight drying time before judging the results.

Step 2. Final Voicing:

The final voicing can be carried out when the action is perfectly regulated and the instrument in tune. **Note:** Any imperfection in the action regulation will result in energy loss and hence in less tone—or in more effort during voicing! In other words, "A perfect action is the foundation for a perfect tone."

In principle, the pre-voicing techniques and steps are repeated during final voicing. However, the shaping of the hammers and the deep, radial shoulder needling should not be necessary (but could in rare cases if the felt lacks quality and drastically changes after pre-voicing). The focus now is in the upper hammer area close to the strike point. Shallow needling is required here in general, in order to preserve the felt density of the almost untreated striking area of the hammer!

The philosophy behind this procedure is to achieve a dense/hard strike point area, which "sits" on the elastic hammer shoulders. Playing such a hammer pianissimo produces a soft but clear tone, which can be augmented dynamically with fortissimo then producing a powerful, brilliant tone without exaggeration. The brilliant character of the sound stays the same in all dynamic ranges due to the flexibility of the hammer felt.

The work should be started by listening to "open" strings and then perfectly fitting the hammer felt to the strings. We refer to the New York chapter for detailed description of this important work! Very fine, used sandpaper of 180 grit should be used for this purpose.

Chromatically playing all notes now will reveal good and bad, loud and soft tones. Needling the bad ones in the shoulders as necessary again and carefully the others closer to the strikepoint with shallower needling will produce an even sound range. Afterwards, single-string voicing should follow, which will "clean" the sound of every note: With the use of a felt wedge listen to every string in a unison and mark (with chalk on the key) the part of the striking point (left, middle, right) which needs attention. Those felt spots should then be needled accordingly (shallow stitches!), preferably with one needle in the tool for precise work.

After each step the action must be installed back into the piano and the tone result checked. Repeated 3-needle stitching, checking and filing the hammer strike point and single-string voicing will be necessary until an even sound is achieved throughout the whole keyboard.

During final voicing the shift/left pedal voicing must be carried out as well. Please see the relevant New York chapter for instructions. While adjusting the shift of the keyboard please make sure (where possible) that the strike point of the hammers will have 5 string grooves. By doing this, separate voicings for both the normal position and the shift are possible, resulting in different sound characteristics.

Notes on Boston and Essex Hammers

In principle, most of the techniques described for the voicing of Steinway Hamburg hammers apply to Boston and Essex hammers as well.

The form of the hammers should be filed with sandpaper to achieve an egg shape, where the striking area is slightly pointed.

Needling of Boston hammers can be done with deep radial treatment in the shoulders, while going up to the striking area with rather shallow needling. (Please see description of Hamburg Steinway voicing.)

After levelling strings at the strikepoint, care should be taken to fit the hammers to the strings, i.e. filing the hammer felt striking area for perfect fit to all unisons. The hammer must strike the individual strings of each note uniformly. "Open" strings will negatively influence the tonal character.

Ironing the hammer felts will improve the appearance of the hammers, however the striking area should not be touched while ironing, because it could change the voicing.

In cases of a Boston requiring more power and brilliance of tone, the hammer felt can be hardened ("juiced") with a mixture of nitro thinner and styrophor*. The material must be of a rough grit, very white in colour. Take a big bottle with a lid (for closing) and fill it halfway with nitro thinner. Take styrophor and put enough into the bottle until all of it is saturated by the nitro. Close the bottle and wait until the material is dissolved. Now you can open the bottle and pour the solution into another bottle without using the sediment material on the bottom of the bottle. (Styrophor always carries some sediment which should not be used for our purposes.) Finally the solution must now be thinned with nitro at a ratio of 1:1. Just fill an equal amount of nitro into the solution, and the hammer juice is ready!

* **Note:** *A mixture of keytop material and acetone can be used in the same manner. Steinway recommends 1 keytop per 8 ounces of acetone. Prior to use, the solution should set overnight to ensure that the keytop has thoroughly dissolved.*

It must be a thin/liquid solution, because it must be applied to the hammers by means of a syringe. Not much more than a drop of the juice needs to be put directly onto the striking area. Allow a minimum drying time of approximately 2 hours before testing the tone and carrying on with voicing/needling. Preferably and if possible let it dry overnight, which ensures that the hammer felt is dry and no late drying reaction will change the sound after the final voicing. The juicing of the felt with the nitro-solution is invisible, by the way, as it is colorless material.

While the hardening of the felt was done directly in the striking area, the needling after drying must naturally be done there too. At this stage of the voicing, each single string of the unison should be listened to and accordingly needled individually with shallow (not deep) treatment in the striking area. The felt can still be needled nicely although it was hardened! Listen for “open” strings again and file the striking area accordingly. If the building of tone is not enough, the treatment can be repeated completely or partially.

