Focusing the Hammer on the String

Laying the foundation for voicing

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The tone of a piano is initially generated by its hammers striking its strings. Much of the character of that tone comes from minute details of how the hammer moves, and exactly how it strikes the strings. High-speed videography makes it clear that a great deal happens during the movement of the hammer to the string, and during the period of time when it is in contact with the strings. Hammer heads wobble side to side, shanks flex, and the hammer's rebound from the string is not instantaneous, but lasts perhaps three vibrations or so of the strings.

Ideally, every hammer should move absolutely directly to the strings, without wobbling, with the mass of the hammer centered on the shank, and should strike all strings of a unison exactly simultaneously. When these things occur, the tone color will be more focused, the voicing gradient will be more even and consistent, and fine voicing will be possible. When these conditions are not present, there is chaos in the system, and the result is an unpredictable instrument, with notes that stand out in more or less random ways at various volume levels. When this is the case, sticking needles into hammers will simply mask inherent inconsistencies.

We can reduce the chaos and establish "ideal" foundational conditions by careful preparation of the action, grand or upright. The steps include center-pinning shanks or butts; traveling; squaring the hammers on the shanks; filing hammers so that their crowns are in a very straight line; leveling strings; mating hammers to strings.

Pinning

We begin by center-pinning shanks or butts, so that the movement of the shank will be based on a firm foundation. The word "firm" is key, far more important than friction. Friction may or may not correspond with firmness: a spongy action center can have high friction. Ideally we want consistent friction, but more importantly we want consistent firmness.

We want to maintain as high a density of felt as we can obtain while keeping the friction within the bounds needed for function. So we want to remove as little felt as possible, ideally none at all. When we repin because the friction is too low, we generally find that going up one half size (0.001") will yield too much friction. And yet the existing pin is too loose, and has too little friction. In that case, the dimension of the felt needs to be changed by something like 0.0005". I believe that is best done by packing the felt, using friction and heat of a burnisher, together with lubrication via Protek CLP. If that is insufficient, then a bare minimum amount of felt should be removed.

Efficiency is paramount, so tools should be laid out carefully, and procedures standardized and repeated exactly for each of the 88 parts to be worked on. It is necessary to cultivate habits, so that the hands and arms do their work in a relaxed and certain way. Use of tools like the Mannino broaches is essential for precision and control. For an entire set, one can generally find a pattern that will work for all centers, perhaps 15 rapid in and out strokes, or perhaps one time through with the roughened area followed by 10 in and out strokes. The burnishing strokes must be quite fast so as to heat the tool and the felt, as the heat will help to set the fibers in their newly compacted state.

Travel and Square

These two procedures are closely connected. My squaring method requires refined travel as its foundation. Refined travel ensures the hammer moves directly to the string, and reduces wobble. Squaring balances the mass of the hammer on the shank, again reducing wobble. Experience shows that refining travel and square produces a more focused sound.

Travel

Uprights

For uprights, traveling is best done by using a broad straight edge to push the hammers from rest position to strike position, and then allow them to fall back to rest position. This should be done fairly rapidly so that any lateral motion of the hammer is readily seen.

Mark the moving hammers on the side from which they are moving (as opposed to the side toward which they are moving). Use a code to indicate how much they are moving: a double line for two layers of travel paper, for instance. Mark the hammers of a whole section, or the whole action, remove each marked hammer in turn, apply the amount of travel paper indicated to the side of the flange corresponding to the mark, replace. Generally two or three passes per section will suffice to achieve pretty refined travel, good enough for uprights. Since upright butts are relatively difficult to remove and replace, it is wise to be careful in marking the relative amount of travel paper to be applied, and to check your work as you go to calibrate. I try to remove any given hammer only once, and usually succeed for most of them.

Grands

For grands, please see my article in the November, 2008 PTJ for details. Briefly, the action is set on the bench with hammers and flange screws toward the bench. The key stop rail or something similar is placed between the screws and the bench, to provide a pivot. The stack is rotated rapidly up and down, to the point where the jack tenders touch the let off buttons (which corresponds to how far the hammer travels to let off), with your eye placed so as to watch any movement side to side of the hammers. Those that move are marked on their tails, on the side toward which they are moving, using a code similar to that given above for uprights (showing how much paper to place and how close to the screw).

After marking all hammers, or all hammers in a section if you prefer, rotate the stack so that it is in its normal position and all hammers are hinged upward. In that position, the tails and their marks can be seen. Remove those that are marked, and install the appropriate amount of paper on the same side of the flange. I generally repeat the process three times for grands, refining a little more each time.

Square

The most precise and efficient way I have found to square hammers begins by pressing an individual hammer forward to about the letoff point. While holding the hammer in this position, center the hammer molding at the middle of the hammershank between the neighboring hammers: make the spaces equal on each side by spacing the hammer using a flange spacing tool or by loosening the screw and shifting it. Now let the hammer return to the hammer rail. Note the spacing of the crown of the hammer between the crowns of the neighboring hammers. If the spaces are not precisely equal when the hammer is returned to rest position, heat the shank and twist it until they are. Check your work by moving the hammer forward and back again. Precise judgment of spacing is the key here.

The angled sections are somewhat more challenging. The eye should be positioned so that it is sighting at the same angle as the hammers, and is precisely in the middle between the two adjacent hammers. If you can see a bit of the inside of each of the adjacent hammers, you are in the right spot. Angled hammers are sometimes leaned slightly – tenor hammers toward treble, bass hammers toward bass – but only a very small amount. I am not sure whether the small difference is significant. (It compensates for the natural flex of the hammershank caused by the weight distribution of the angled hammer.) Squaring by the method described will result in angled hammers appearing to "scoop" toward the string, but spacing between adjacent hammers will be close to optimum, with respect to avoiding rubbing.

The most efficient way to do this is by sections, doing every other hammer: for uprights, "thread" a strip of wood between every other shank: that is, insert the wood while pushing forward every other shank in turn, so that the strip is supporting half the hammers in the section. The strip should be of a size that will push those hammers to let off distance when slid down toward the butt, about 1/2 – 5/8". A little sandpaper on each edge will help hold it in place. For grands, simply raise every other hammer and place a strip of wood (with sandpaper glued to one side to keep it in place) close enough to the knuckles to hold the hammers at about let off distance. (The key stop rail can also serve this purpose).

Then center every other hammer between its neighbors as described above. Remove the strip of wood, let the hammers go back to rest position, and burn shanks so that the crowns are evenly spaced. Then repeat the operation for the other half of the hammers (all even hammers, alternating with all odd hammers). This goes quite a bit more quickly than doing them individually. For uprights, it can be helpful to draw a line with a pencil to show where the middle of the shanks are,

as it is at precisely that point that you must look to center the hammers between their neighbors initially.

Filing hammers

I won't go into detail about hammer filing here, but simply point out that regardless of method (gang filing or individual hammers, strips of sandpaper or paddles), hammer crowns will not end up in a perfectly even line automatically. This is true also following a final "shoe-shining." It is necessary to look at the hammers and do the final small corrections to achieve a truly straight line. This is an important step from the point of view of efficiency: if the strings are level, the hammers are traveled and squared, and the crowns are very even, the final step of mating hammers to strings will be much faster, and will lead to better results.

Looking at the hammer tops with a straightedge is a good technique. It is also a good idea to be aware of the crowns while doing various regulation procedures, like adjusting capstans, setting drop and back checks, as small inconsistencies are often noticeable.

Leveling Strings

A number of people have been teaching techniques for string leveling, since string levels similar to those developed by Fazioli became available a few years ago (and other designs have since become available). I would like to emphasize a few principles. First, the termination bends should never be extreme: when bending the wire, always leave some room to be able to bend it more. Second, it is far more important that the three strings of a unison should be in a plane, than that that plane should be level. Third, use of a magnet, while convenient and sometimes necessary (for uprights in particular), will affect the results to some extent, making them less precise (the magnet will pull the strings into line with one another).

For uprights, a magnet is necessary in most practical circumstances (laying the piano on its back is possible, but not usually practical). In this case, we simply get the strings into a single plane, not worrying about level per se. This will allow us to mate the hammer by adjusting the full crown, as opposed to custom fitting to each string. A very weak magnet should be used, one strong enough to hold onto the strings, and to mute the sound in a noticeable way, but no more than minimally stronger than that. It should be placed on the strings about 10 – 20 mm from the V-bar. Farther, it will tend to pull the strings of the unison together (especially in the tenor), and tell you the strings are level when they are not.

The strings can be plucked with a length of music wire. High strings are lowered by pressing on the string close to the V-bar, or, if necessary, hammering a brass drift lightly with very small hammer. There are two conditions: either the middle string is high (one of the outer strings is free, and the magnet can rock from one to the other), in which case the middle string needs to be lowered; or the middle string is low (vibrates freely), in which case one or both of the side strings are lowered. It

generally takes me about 30 minutes to level a set of upright strings, well worth the time.

For grands, strings are pulled up to make their bends more positive. A good procedure (when possible – usually on relatively new strings) is to raise the left string by feel (making a positive bend, but not pulling too hard), raise the right string to make it the same level, and raise the middle string to that plane. Strings can be lowered a little bit, should you pull one up too far, by pressing them downward. I use a level that can sit on the unison next to a strut in most cases. The level should always be placed at the strike point of the string (very near is good enough: right in front of the dampers is usually within a few mm of the strike point). In the capo section, there is often not enough space between the dampers and the capo to place a level. In this case, it pays to remove that section of dampers, level the strings, at the same time do refined alignment of hammers to strings and let off, then replace the dampers.

Mating hammers

The hammer should be pressed VERY lightly against the string, by a method that avoids influencing the angle of the hammer. We want to emulate what will happen when the shank throws the hammerhead at the strings. It is a good idea to develop the habit of pressing so that all strings sound equally wet, then press a tiny bit more so they sound slightly less wet, and so forth. At some point, you can distinguish between the plucked sound of different strings, and correct them by minor filing of the hammer crown. The subtlety of how precisely hammers are mated has an enormous impact on tone.

For uprights, the hammer should be pressed toward the string by using a finger on the shank. The finger should rest on the hammer rest rail, and should press the hammer sensitively toward the strings. Pluck the strings with a piece of music wire or the like. A sanding paddle for a single unison, with something like 320 sandpaper on one side, 600 on the other, can be used to adjust the hammer crowns. A piece of music wire pressed into a hole on one end of the paddle can serve as a plucker.

For grands, my preference is to press upward on the jack to block the hammers on the strings (this has a fringe benefit of checking let off distance). Alternately, the hammer can be pulled up to the string with a “hook” (actually a piece of wire bent at a right angle, so that it does not tend to pull the shank one way or another). I find that a strip of cloth on top of the jacks and repetitions does not give me sensitive enough results, though others seem to like that technique.

Andre Oorebek’s clear plastic sand paddle, with a narrow strip of sandpaper attached down the middle (available from Pianoforte Supply), is an excellent tool for mating. I attach a second, slightly coarser strip of paper to the other side.