Getting the Hang of Hanging Hammers

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This class is totally unrealistic. You can do a hammer job any number of ways. Richard does everything in this presentation. Sometimes you won't need to, sometimes you will. Richard taught junior high school music, and started being a piano technician in 1973. Hammer hanging is like everything else we do: first we learn the basics, and then we learn increasingly more details. Unless you are really efficient, it's sometimes better to have someone else do the job, or at least parts of the job. Another name for this class might be "The Perils of Grand Hammer Replacement." In this class we will demonstrate the number of ways you can lose money by hanging hammers.

If you have too many leads in a key, you will have a terrible time. Working on hammers is balancing the weight. Until you know intuitively from experience and from doing research, there are many factors involved in this chance to make things better. Unfortunately, all the extra work requires a lot more money than the average customer is willing to spend. We must look at the piano to determine what is the minimum we can do to make things better? Hammers are never the only part needing replacement.

What shape is the piano in?

Look at this job the way you would with any rebuilding job. If the hammers are worn out, most likely the key bushings and the back checks are worn out as well. It's the thing that you don't do that wrecks the piano every time. In fact, look what wears simultaneously as the hammers wear out:

- Key bushings
- Back checks
- Wippens
- Key end felt effects damper timing, sostenuto function
- Pedals and trapp work
- Strings (have any been replaced or spliced?)
- Damper System
- Pin Block
- Soundboard (If you pluck the string and the sound does a nose dive)
- Plate (Jack Lemon had a small Bosendorffer that wouldn't hold a tune due to a crack)

Is this a good investment?

Is it time to retire the piano and start over? There are three reasons for replacing hammers:

1. Worn (no tone)
2. Tone
3. Touch (no up-weight)

Adding Weight.

Add weight to the hammer and shank with mini clamps ($3/5^{th}$ inch). One mini-binder clip weighs .7 g. This is a good way to postpone an expensive job. Too many binder clips produces a 7g increase at the end of the key, which is a lot. Install the clip tab vertically for center of gravity

and to ease of removing. Now we have 11.2. It just so happens that 2 #25 center pins weight 6g. Instead of .7g, our clip weighs 1.3g.

Let's do some math.

- Our hammer and shank originally weight 10.5 g
- We added a mini binder clip and the weight increased by 0.7 g at the hammer.
- The result is 11.8g
- Our 1.3 g increase at hammer produced a 6.5 g increase at end of key, without changing key leading.
- If you need more than 6.5 g, add a second clip with or without #25 center pins
- You can adjust touch-weight by using gram weights on end of key and sliding binder clips back and forth on the shank.
- Strengthen repetition springs and check the rep height.

Potential Problems

We as technicians are never content to deal with a problem until we can find the answer. Correcting without pre-knowledge can really screw things up. Think ahead.

- Parts for pianos no longer in production
- Incorrect parts
- Geometry issues
    - Check jack-knuckle alignment (straight line)
    - Capstan/wippen heel alignment (centered) If too far back action will be heavier.
    - Key height (key slip & fall board)
    - Key dip (10mm /- .5mm)
    - Blow distance (44-47 mm: after-touch)
- Problems created by last technician
- Key leading issues
    - With too many leads the key won't come up at fortissimo or fast repetition
    - Magnets lose inertia
    - 5/8"leads are wrong

Hammer and Shank Selection

Become familiar with one brand of parts

Manufacturers are trying to sell their parts. Know what parts you want because you know what the weigh-off will be.

Measure action ratio

- Key 2:1, wippen is ,hammer shank 6:1
- Knuckle replacement
    1. Saw off the old knuckle
    2. Coat the cut with super glue, and touch with accelerator
    3. Chisel off the roughness
    4. Place the shank in a slot wider at the top than the bottom and clamp it against the back and tightly. The cutter jig is a slot cutter that comes in different core diameters and adjusted to cut 17mm at the hammer flange.
    5. Always use the smallest knuckle you can get.

6. Glue in the knuckle with the gap-filling super-glue.
7. Position the knuckle precisely and at a right angle, hold it in place. The run-off can be cleaned up later.
8. The let-off and the drop had to be adjusted to compensate for the change. The jack and knuckle are no longer straight and the geometry is different. The knuckle spread makes a difference. Changing the action ratio changes the efficiency of the action, so always measure the action ratio.
9. 54 down, 24 up. The friction is improved. Originally it was 63 down, 53 up.
10. Use the Spurlock action tester
    a. Place the block on the key and measure

Making an Estimate

In addition to new hammers, what is the least amount of additional work necessary to produce a good result, assuming no other problems which will compromise the job)?
Keep in mind that these are wood and leather parts subjected to friction and pressure.

- New shanks and flanges
- New key bushings

How does one return a daily labor rate? How many pianos you tune in a day and how much you charge is your rate. Your time is worth much more than what you probably are getting now.
What will this job cost?

- Key bushings = 1 day labor + $25 in parts (the wood has to dry before installing bushings)
- Hammers, shanks and flanges = $1000 parts
- Pre-voice, boring and shaping = 1 day labor
- Hanging hammers, trimming shanks = 1 day labor
- Subcontract your hammer job and add the amount to your estimate
    - Having it done for you could correct geometry problems
    - There is a learning curve
    - Richard has worked in three factories, and they all use a straight edge
    - Your eye will pick up imperfections, but a jig won't
    - Take a straight-edge under the hammers and move it left-to-right and you will see the imperfections right away
- Costly mistakes
- Possible regulation and tonal problems
- Expensive hammer preparation equipment
- Suppliers offer hammer prep and hanging services
- Check your PTG Membership Directory under "Hammers" for a supplier list and contact information. This is especially worth it if we hang only one set of hammers a year, since most of us are tuners, voicers and regulators.
- The first thing any piano designer makes is a scale stick: a straight edge with the holes of each part marked on it.
- Burning, traveling, spacing shanks = ½ day labor
- Action regulation = 2 days labor

- Weigh-off & repining: standardize the friction because the leads need to be adjusted = 2-3 days labor
- Tuning, Voicing, Regulation, Aligning hammers to strings = 1 day
    - You have to work voicing from the bottom to the top.

Parts = $1025
Labor = 10 days
If your daily labor rate is $350, your estimate should be at least $4525, which is enough money to buy a decent new upright.

Now you can make a decision: are the parts available, do you have the proper tools and experience, and is the job worth it? Richard tunes to support his shop decision. He hasn't made any profit on any piano he has rebuilt. He grew up knowing what good work was. Working in the shop is fun, especially with friends. Information is shared, a fun time is had, and a good piano is turned out. However, financially the work is not profitable.

Compare an old piano to an old car. Because pianos wear gradually, people think that how they should be. Francis MaHaffey built many crude tools but was very creative. The difference in age between 40 and 68 in people is not 28 years: it's exponential. Consider the difference between 85 and 95 years old. Now look at the difference in years of a piano.

Hammer-Hanging Procedure

If you've decided to go ahead, think carefully. This is not a simple decision: it's a lot of money. Richard custom bores his hammers to the string height and the action center height. Measure the string height with a gauge so it can be duplicated. Keith Bowman's string height gauges can be calibrated so they can be duplicated identically and give a reading in mm or inches. He makes these to order, in the custom tool section in the Renner catalog

- Transfer string height to bench target. Stick 3M striping tape to the bottom of the target. The magnet attaches to the target. Measure by raising and lowing the target until the pointer matches the original.
- Determine the bore distance.
    - Most companies over-center their hammer bore by 1-2mm, which is less than the parallel distance, in order to account for the string angle and the flex of the string when it is struck. This usually guarantees that the shank will be off the rest cushion, and places the hammer at a right angle.
    - Examine the hammer center height, the number of leads, and the bore distance.
    - Over-center the hammer
- Cut the hammer to shape
    - Cut off the excess tail
    - Curve the tail
    - Taper the tail
    - Bore the hammer core

Hammer Boring
Richard has a hammer boring spread sheet for a parallel bore. The key number is the hammer length. Subtract 2mm from the hammer length on the chart. The factory bores one set of specs

for the bass and another set of specs from the tenor to the treble, even the plate is flat. By boring off the tail you get a more accurate boring distance. For a copy of Richard's Excel hammer boring spreadsheet, go to

Pre-Voicing Fixture

Make a clamp. Affix 80 grit sandpaper on one side and 1-1/12" bushing cloth on the other side of the hammer clamp. These hammers will not move. Keith sells a version that is half as long, which does half a set. Pre-voicing must be done before working on the hammers. Treat the hammers like Renner blue point hammers. The hammers must be at a right angle to the caul so they are vertical. If you squeeze them together, they will lean together at the top. The rails are held together with Gestaco clamps.

Needle Mark the strike point in the center of the hammer, and two points on either side of the strike point. Make three lines down these points with a chalk line so you know where not to needle. Record the section changes, since when they are clamped they all look the same. With this set-up, pre-voicing can be done in fifteen minutes. Do deep needling on the shoulders. Don't needle within the lines.

Tapping the hammers from the top makes sure that the hammers are down in the caul; it also recompresses the swelling from needling. Hit each section with a dead-blow mallet ten times. With the blue points you need only

File. Start with 320 grit, then use 80, 150, 400, and 1000. Normal felt removal with 80 grit sandpaper fluffs up quite a bit. Make three buffing swipes on each side.

Take the existing condition and duplicate it. Don't try to put a point on a round hammer. When you're done, the hammer will be the same size it was when you started, because it expands. Drop and bounce a hammer before this process, and then drop it again after. It should bounce; you are trying to make this into a pink rubber ball. A hammer should be the same density on both sides because you want that spring to be equal. If you want a hard sound, file some felt off. If you want it softer, needle some more. The point of pre-needling is to get the dynamic range. Don't be afraid to file the dead felt.

Trim hemmers to Correct Length

For end hammers in each section, set caliper for total length (boring distance + 1" tail). With a 3" radius you get the back-check parallel to the back of the hammer. Decrease the radius and you won't get as much sensitivity.

Transfer measurements to the hammers on the end sections. Connect the samples, put them in the caul and run them through the band saw. Every hammer will be a slightly different length because we have measured the string sections. All the back checks will be the same height and the regulation will go more smoothly. Belt sand by eye to the finished length so they are square at the bottom and the hammers match your caliper reading.

Bore hammers with a 5C collet chuck to hold the hammer core. This enables the hammer to be centered and drilled accurately. The bore distance varies with the string height, but the holes are all perfect, with a 1" tail.

Cove the tail the tail with a rotating oscillating drum sander.

Taper the tails with two sanding discs attached to two motors. The hammer is pushed back in a slot for the tails to go between the discs.

Arc the tail with the hammer already hung. Use 24-grit sandpaper on a small belt sander. This rough paper scores the tail enough that chequering is not necessary. Checquering is used for improper geometry.

Soften the edges with a piece of half-round brass stock with 80 grit sandpaper glued to the inside concave side of the brass. Make three firm strokes over the tail to remove the roughness.The idea is not to rip apart the back check. This takes off all the sharp edges.

Register the regulation bench. Set up string height targets, front/back stops, a bass/treble stop, and a flat level bench. These stops are made with a router and a drill bit.

Register the action. The CF regulating bench from the factory fits all the sections perfectly. Duplicate the action as if it were in the piano.

- Center action under targets
- Locate strike point of old hammers to front edge of target
- Register position of action on bench with clamped blocks or adjustable stops
- Transfer string grooves to tape, regardless of the hammer location. The grooves show where the strings actually were. Space the hammers to these marks.
- Install sample hammers.
    - Most good pianos have hanging distance of 129-130mm.
    - Mark the center of the hammer molding.
    - Clamp it down in the jig.
    - The thin string allows you to move the hammer incrementally until it is perfect
    - Use a jig for marking the hammer molding quickly and accurately.
    - Mark both sides of the hammer centers.
    - With the hammer on the shank, adjust molding center line to gauge
    - Install all hammer shanks
    - Set four sample hammers
    - Make sure the centers and the tails are in straight lines
- Travel the worst shanks
    - Travel paper
        - Mark Adams in San Diego found a Japanese paper shredder with a hand crank
        - Get a long letter opener and make strips from a roll of gummed paper tape
        - Post-It corredction tape compresses and is not good to use
    - Stick the paper on the flange
        - Lick the paper, stick it on the flange, hold it and rip off the rest
- Regulate samples using the bench targets
    - In the high treble, test each hammer individually for the best tone
    - Adjust position as needed
    - Put them at 130, center the cheek block, and record the original position of the action.
    - While playing the notes, shift the action in and out for the best tone.
    - Mark the line on the key bed where the tone is best, and measure that distance.
    - Mark that distanced on the shank, and move the hammer out by that amount: take the time to find the correct strike point
    - Place one drop of super glue between the molding and the shank to hold it. Once the shank stud is cut off this glue mark will disappear.
- Hanging Angled Hammer Samples Accurately (any angle 6 degrees or more)
    - Figure out the differences based on the angle of the hammer
    - Measure the width of the hammer molding (usually 10-11.5 mm)
    - Mulitply half the widgth times the sine of the boring angle

    - Add or subtract the result from the hanging distance.
    - For every degree of angle you will either add or subtract .6 mm.
    - Multiply helf the width x sine of boring angle = amount to add rto or subtract from hanging distance
- Rival Crock pot with a 1" hole
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- Strike point
    - Hang hammers at the strike point. Most factories hand them at the rest point, and also burn them.
    - Between the time the flange is screwed on the railand the time the hammers are on, things will change; therefore don't travel the hammers until the end. The screws will have to be tightened several times.
    - Line up strike points with straight edge.
- Fit the hammers to the shanks
    - Use tapered reamer and shank reducer.
- Glue hammers to shanks
    - Use molding glue, the hammers will be nailed.
    - When using hot hide glue you have flexibility.
    - Hot hide glue is water-based and swells the wood. (don't mix it too thick.)
    - Use the reamer to shape the hole.
    - For removal, hide glue pops off, whereas molding glue must be heated.
    - The tendency with hot hid glue is that the tendency is to make the hole too tight.
    - Bill Spurlock makes an excellent hammer hanging jig, although a straight edge is still Richard's favorite tool
    - Hot Hide Glue
        - Glue should be 140-150 degrees, so use a thermometer.
        - Use distilled water
        - Bjorn Industries (704) 364-1186 makes the best hot hide glue in the country
        - #192 TGE grade
        - Fill the water just a little above the glue line.
        - The glue will gradually dissolve whether it is pre-soaked or not.
        - Use a ceramic or glass glue container that is suspended over the water and not touching the bottom.
        - When you stir the glue, it should go "drip, drip, string."
    - Make a glue applicator that fits over the end of a shank
        - Apply the glue to the shank end
        - Apply the glue inside the hammer hole
        - Slide the hammer on and spin it
        - With the straight edge, touch the hammer with a light touch to line it up as the glue is hardening.
        - The advantage of hide glue is that you can move it up to five minutes.
        - After five minutes you can soften it with a heat gun.
        - Take your time and make sure everything is straight.
        - Check alignment with a square.
    - If along the way you see one has changed, remove it, ream it and glue it back on

- Trim the shanks with a Japanese saw.
    - Smooth with a disc sander
    - Start by the felt and go down, without touching the scored arc

Finish up the job.

- Assemble the action
- Travel and burn shanks and space hammers to strings, using una-corda pedal.
    - Line up the hammers
        - The screws have now been installed a number of days and have gotten establishes
        - Line up the hammers so when you shift them, the end of the hammer is even with the end of the string.
        - Knock off the corners of the hammers.
            - This prevents zipping when using the una-corda with the sustain.
            - Rub them with 80 grit at a 45 degree angle
            - Support the tails at the strike point on a piece of Masonite, and go over the tops with 1000 grit.
    - Travelling
        - Shank and hammer moving left or right as they rise to string) occurs when a flange or center pin is not horizontal.
        - Using traveling paper to shim flange in direction of travel restores horizontal condition.
    - Burning warps the shanks with heat
        - The Rappaports use an alcohol lamp
        - Usually used for band instrument repair to heat the shellac
        - Burning corrects hammer which is rotated when compared to adjacent hammers
    - Spacing
        - Knock the corners of the hammers off with 80 grit on the sides, then make one swipe on each side at 45 degrees
        - Test with the una-corda pedal. It may not zip with just the sustain or just the una-cord pedal, but it will zip with both pedals depressed if the corners are not knocked off.
        - Watch this on the movie “American Grand” on Amazon
    - Shaping
        - After traveling, burning and spacing, hammers should be raised to the strike point and lightly shaped to restore a horizontal strike surface.
    - How do you tell if it needs traveling or burning?
        - Watch the shanks to see if they move when being lifted together? If they do not move, then the shank needs to be burnt.
        - If the hammers look straight but the hammer moves on lifting, then the flange needs paper.
        - If it needs both burning and travelling, travel first.
- Space whippens to shanks
    - Check let-off buttons & capstan alignment
    - If whippens are hitting one side more than oanother you are using power

    - If the capstan alignment is bad, you are losing after-touch because the action ratio is changed
        - The solution is to plug all the holes and reinstall the capstans in a straight line
- Fine-regulate the action
    - Assemble action
    - Space wippens to shanks
    - Regulate action
- Re-pin all the parts to standardize friction
    - For consistent weigh-off, pinning is significant
    - Richard drills holes in the whippens to remove mass
    - He also narrows the shanks as they go toward the treble.
- Weigh off new parts
- Use gram weights to determine touch weight
    - Remove excess lead (wear gloves)
        - If removing key lead, in order to maintain the stiffness of the key, plug the holes in the keys with CA glue
        - Many leads can be pressed out, although some must be drilled out
        - Plug holes
            - Drill out old lead holes to accept plugs
            - On drill press, cut out the plugs from white spruce or pine, or use a tanning cutter
            - Glue, trim and sand
            - Insert and swage additional lead
- Install action in piano
    - Fit strings to hammers
    - Voice hammers
    - Tune piano
- Get paid and learn from your mistakes
    - Sit down and analyze time spent
    - Where did you make and lose money?
    - Record an estimate to assist in making future estimates
    - File every estimate