Hammer Replacement

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3/4/2010

Why do we replace hammers? Weight, geometry and tone.
Buy an accurate scale and weigh parts.
The problem, 98% of the time, is hammer weight and knuckle placement.

What is grand hammer replacement?

1. Hammers are never the only part needing replacement.
2. What shape is the piano in?
3. Is this a good investment for the customer?
4. Potential Problems

1. Hammers are never the only part needing replacement.

Other items to consider:

- Key bushings
- Back-checks
- Wippens
- Key end felt
- Pedals and trapp work
- Strings
- Damper system
- Pin block
- Soundboard
- Plate (cracked?)

2. Examine all the parts

- Assess every aspect
- Is the issue function, tone, or total wear?
- What alternatives might better improve the piano?

Here is an alternative:

Staples binder clips (vs. Yamaha's touch-weight adjusters)
What will happen if we put one of these by the hammer? Weigh the original hammer weight, e.g. 10.5 grams. One binder clip weighs .7 gram. Added to the hammer produces a 3.6 gram increase at the end of the key

Take advantage of Action Ratio

- There is approximately a 1:5 relationship between weight added to or subtracted from hammer and weight at end of key.
    - 4:1 is a lower action ratio and will lift a heavier hammer a shorter distance
    - 6:1 is heavier hammer: bigger hammer, deeper dip. On a bicycle, this would be harder to pedal, but you go farther on a stroke.

    - Force = mass x acceleration (therefore a heavy hammer is not always the answer. A heavy hammer accelerates faster)
- .7 gram. Added to the hammer produces a 3.6 gram increase at the end of the key
- Install the clips on the underside of the hammer shank and clip off the little ears.
- If you want the hammer really heavy, add #25 center pins. Two #25 center pins add .7 grams, and they fit right inside the little slots on the clip. This makes an amazing difference.

Let's do some math

- Our hammer and shank originally weighed 10.5 gram
- We added a MiniBinder Clip and the weight increased by 0.7 gram at the hammer but 3.5 gram at the end of the key (.7 gr.x5).
- We added two, #25 center pins (@.3 gr.)
- D

3. Is this a good investment for the customer?

What does this mean?

- Our 1.3 gr. Increase at hammer produced a 6.5 gr. Increase at end of key, without changing key leading.
- If you need more than 6.5 gr., add a second Mini Binder Clip with or without #25 center clips.
- You can adjust touch-weight by using gram weights on end of key and sliding binder clips back and forth.
- This takes less time, costs hardly anything, makes more money and makes a noticeable difference.
- You can extend life of worn out hammers with a morning's work and a couple of dollars spent on parts. Tone will also improve
- Don't forget to strengthen repetition springs and check repetition lever height.

4. Potential Problems

- Parts for pianos no longer in production
    - The jack angle and the repetition heal height have to be right
- Incorrect parts
    - Putting an incorrect gram weight in the bass could make the hammer very heavy
    - Norm Nebletz says, "If you can't make it better, make it different."
    - Know what you're doing
- Geometry parts: quick check for geometry problems
    - Jack/knuckle alignment straight line?
    - Capstan u/wippen heel alignment: centered?
    - Key height: key slip & fallboard?
        - The key should be 18-22 mm above the key slip.
        - If it's too low or square, it's wrong.
    - Dip:
    - Blow: 42-44 mm

    - Jack clearance in window
        - The jack should be stopped by the front rail punching, not with the repetition cushion (the jack tender will break)
- Problems caused by last technician
    - "Skilled plagiarism is always better than inept creativity."

Friction Reduction

- Put a straight edge along all capstans: this is key to consistency.
- Re-pin all centers to reduce as much friction as possible
    - A well-pinned hammer flange should move upwards when tapped. It's about 4 swings.
- To relocate a knuckle:
    - If you move a knuckle, the weigh-off is constant.
        - Use the same size knuckle that was on the original shank.
    - Saw off the old knuckle
    - Touch super glue and accelerator to the cut part
    - Chisel off any extra wood
    - Clamp the shank into a jig
    - There are four different diameters of slot cutters. Cut 17mm into the shank
    - There are two stops on the router table, one to keep the blade from running into the pin, and the other to
    - Glue on the new knuckle with gap-filling superglue; get it square
    - Put it back in the action
    - As a result, change the let-off and drop, and raise the hammer
    - Check the difference in down-weight: there should be a big improvement in the friction (fewer grams of friction)

Hammer and Shank Selection

- Become familiar with one brand of parts
    - Try them all, then pick one company and learn to work with those parts
    - Pre-voicing hammers is one thing most people don't do, but that is significantly effective.
    - For example, Richard likes Renner
    - String leveling and
- Measure the action ratio
    - Key ratio, wippen ratio, hammer ratio
    - Spurlock Ratio Tester
        - Jig
            - Key depressor, to automatically depress a natural by 6 mm.
            - Spans 7 keys
            - Weight approximately 150 grams
        - How to use
            - Measure hammer rise (27mm)
            - Divide hammer rise by key travel to obtain action ratio
            - 27mm/6mm=4.5

        - For every 1mm of key travel, hammer rises 4.5 mm
        - (4.5-5.5=
- Weigh old and new parts
    - Take off the old one and put on a new one and test it
- Hang, regulate and weigh off samples
    - Check low bass, low tenor, low treble and get them to working

Make an Estimate

- In addition to new hammers, what is least amount of additional work necessary to produce a good result? (assuming no other problems which will compromise which will compromise job)
    - Your reputation is your last piano
- New shanks and flanges
    - Replacing hammers always implies replacing new shanks, flanges and knuckles as well.
    - The knuckle spread is where you can make a huge difference.
    - Hamburg and Steinway use 17mm knuckles.
    - For Steinway, either use the new stack with the new dimension parts, and use the modern wippen. The capstans sometimes need to be moved.
- Key bushings are the wheel bearing of the piano. When you play a key and it goes straight up and down, it makes up for a multiple of other problems.
    - It takes ten days to do all this.
- What will this hammer job cost?
    - Key bushings = 1 day labor + $25 parts
    - Hammers, shanks & flanges = $1000 parts
    - Pre-voicing, boring and shaping = 1 day labor
    - Hanging, trimming shanks = 1 day labor
        - Install yourself or sub-contract?
        - There is a learning curve
            - Keep your shop hot to work with hide glue
            - Costly mistakes
                - What happens if you glue the hammers in the wrong place, cut the shanks too short, etc?
                - Order wrong parts
                - Regulation, tonal problems
        - Experienced people can do the job better, for less time, for a profit
                - Expensive hammer preparation equipment
                - Suppliers offer hammer prep. services
                - Suppliers can help with touch-weight issues
        - Take advantage of the Journal and other resources
    - Burning, traveling spacing shanks = .5 day labor
    - Action regulation = 2 days labor
    - Weigh-off & repining – 2-3 days labor
    - Day in house tuning, voicing, regulation = 1 day labor
    - Bottom line
        - Parts = $1025

        - Labor = 9.5 days (10+ is more realistic)
        - If your daily labor rate is $350, your estimate should be $4525+
        - Knowledge is your business: you can't give it away
            - If you know more than someone else, you will take away their work
            - Know everything about all aspects
            - We are selling a commodity, and that is ourselves
            - We offer complete quality service: be really good at it

Taking Measurements

- String height
    - Use gauge with magnet
- Bore distance
    - Measure the height of the key-bed to the bottom of the string, measure from the key-bed to hammer center, then subtract the hammer center to from the key height.
    - Renner universal moldings are unshaped and too long
        - By subtracting the height of the hammer center from the height of the string above the key-bed gives the hammer bore distance. Add one inch for a tail and cut off the rest.
        - Hammer-shank centering
            - Parallel centering. These measurements will produce a parallel bore where the shank and the hammer are parallel to the string
            - Over-centering a hammer is a good idea. (1-2mm)
                - The hammer is swinging on an arc
                - Better convergence line with the knuckle
                - The closer the hammer is to horizontal, the less inertia it takes to move.
            - Under-centering is worse
                - More inertia to get going
                - Not hitting the string at the best angle
                - Heavier
- Think in order of problem sequence
    - Number of key leads
    - Relationship between capstan & wippen
    - Jack
    - Knuckle position
- Hammer boring measurements
    - Use boring chart
        - rdpt@aol.com
    - Most good pianos over-center
    - Bore parallel; they will over-center after filing
- Pre-Voicing
    - Tools
    - Sanding paddle

        - One side 80 sandpaper on wood
        - 1.5 bushing cloth and then 80 grit sandpaper
    - Clamp hammers
        - Clamp all at a right angle
        - All hammers are clamped together in one long row
        - Put a dot on the strike point of the first hammer and the bass hammer for no-needle zones
        - Learn/know how many times the hammers need to be needled
            - 15-20 in lower bass shoulders
            - 5-6 in high bass
            - Treble is less forgiving, press the needles in
        - Mark the hammers
                - Make a chalk line between these three points
                - Mark the section breaks
            - Under-needle the first tenor hammer
            - Scaling varies from long to short pianos
            - Voice down the upper bass and lower tenor in smaller pianos
        - Compact the felt after basic needling
            - Tap the hammers down
            - This tends to knit back the felt together
            - Makes for better filing
            - Evens up the hammers
        - Shape the hammers
            - Buy a clip board and cut it up to make sanding paddles
            - 80m 150, 220, 400, 1000, 1500 grit
            - Increase the surface tension by whisking the felt off the top of the hammers.
            - Start with the shoulders on each side & com up to the line.
            - When filing, the sound of the felt changes under the sandpaper. When it changes, it's time to move on.
            - This process re-establishes the surface tension of the hammer
            - Typical hammer shape:
                - The distance of the hammer tip to the molding should be the same as the distance from the shoulder to the tip of the molding.
                - Clean hammers with vacuum and compressed air
            - 400-1000 with tape backing. Go sideways, lengthways against the grain instead of shoe-shining. Start low, work up along the sides and finally go across the top. When it squeaks, you're down to really tight felt. This is polishing.
            - The inner produces sustain, the outer produces attack.
        - Trim the hammers

- For end hammers in each section, set caliper for total length (boring distance + 1" tail)
- Mark samples at ends
- Put them in a caul and connect them.
- While in the caul, put them in a jig and chop them off a little long
- Use a belt sander to fine tune the first, middle and last hammers, since they are almost always not the same length. This tapering creates a perfect length hammer for every hammer in the piano.
- Every hammer has a 1" tail. Bore off the head, not the tail.
    - Boring off the tail makes each one slightly differently.
    - Boring off the head makes the hammers always the same distance off the rest rail.
    - Bore
    - Cove
    - Taper
    - Arc
        - with 24 grit
        - The arc angle is 2-1/4 to 3"
        - A 3" arc is more precise and has more contact. The sharper radius has less contact but is more forgiving
    - Soften the edges with an angle iron or concaved file

Action Registration and Regulation

- Bench
    - Bass-treble stop
    - Front/back stops
    - String height targets
        - Ability to record the strike points
- Register Action to targets
    - Center the action to the targets
    - Locate the strike point
    - Usually the middle hammers that are worn are shorter and over-center.
    - Most of the time, #1 and #88 are so accurate that they can set the strike point.
    - If you can guarantee that that action goes back in the same place every time, then you can space the hammers out of the piano.
    - Transfer the original string grooves to the tapes before the original hammers are ever moved or removed. Make a story line by marking the old string grooves
- Samples
    - Install samples

        - Because the treble is most sensitive to strike point adjustment, start there.
        - 140 mm = 5-1/8" is the standard distance from the hammer center
        - Fasten the hammer to the Plexiglas s jig
        - Mark the center of the hammer molding with a jig
        - Mark both sides and connect the strike point mark
        - Plexi-glass gauge
        - Locate the gauge at the center of the center pin.
        - Push the hammer until the center of the hammer lines up with the center of the gauge.
        - Put on 4 hammers at a time with all the tails touching and all the shanks touching.
    - Regulate samples
        - Test individually for best tone, & adjust position as needed
            - Custom fit the top eight hammers
        - Adjust the treble cheek block to the center
        - Record the original position with the action centered in the key block. Locate the action for the best tone
        - Measure the distance
        - Mark it on the hammer shank
        - Relocate the hammer
        - Put it back in, test it again.
        - Make tick marks for the samples, especially in the high treble.
        - If the hanging distance is right on or close to 130mm, use 130mm.
        - Hanging angled hammer samples accurately (any angle 6 degrees or more)
            - Measure width of hammer molding
            - Hammer bored at 6 degrees
            - Do the math
                - Multiply half the width x sine of boring angle
                - 11.5mm/2xsine of 6 degrees = amount to add or subtract from hanging distance
                - 5.75mmx0.1=0.6mm
                - If hanging distance is 130mm, add 0.6mm to outside angle (130.6) or subtract 0.6mm from the inside angle (129.4mm)
                - Standardize everything
            - Allow for the 6/10ths when doing the sample
    - Glue on the samples
        - Slightly turn the tenor hammers toward the bass (less than 1 degree) and the bass hammers slight toward the tenor
        - Line up samples with a straight-edge
- Travelling hammers and shanks
    - Turning screws, gluing hammers, etc. will change the travel.
    - Mini-Shredder
        - Use gummed brown packing tape

        - Turn the crank and you will have all the travel paper you will ever need.
        - Mini-Shredders are available from e-Bay craft work category
        - Envelop openers also work
- Hang the hammers
    - Glues
        - Alophatic resin requires a tighter fit
            - Spin the hammer on the shank to let the glue spread
            - As the glue dries, the hammer will unscrew
        - Hot hide glue
            - Longer work time
            - Prepare the glue
                - Use distilled water for the glue, and tap water for the water bath
                - Use two glue applicators
                    - A dowel with a hole drilled in it, attached to a shank for spreading the shank
                    - A reamed shank for the hole
                - Make the glue fresh for each job
                    - Every time you use it, it makes a weaker bond
                - Measure and fill
                    - One coffee measure is enough glue granules for an entire hammer job
                    - Fill the jar: quickly pour the water in until the glue is covered, then add 1/8" or 1/4" more water on top.
                    - Let the glue soak in the water overnight
                        - This makes the glue smoother
                        - It expands better
                    - Make a three-piece custom glue pot
                        - The base sits in hot water
                        - It has a keyway
                        - Top of crock-pot closes with glue pot lid on for faster heating
                        - The top has only a 1" hole so very little water evaporates
                        - Temperature is around 150 degrees
                            - If it goes over 160 degrees you have cookie dough: throw out the glue
                        - SunBeam makes a great crock pot
    - Ream
        - Standardize all the hammers and shanks before gluing
        - Use a tapered reamer
        - You do not want a tight fit

        - When the glue hits the hammer and shank, the wood swells up like a sponge. Then the hide glue freezes it in that position
        - It takes overnight for hide glue to fully harden
        - Set a stop collar
        - Don't change the boring angle while reaming. Slide it down on the tapered reamer until it won't push any more. Turn it once or twice until it hits the stop.
        - The hammer should go to the bottom of the knurling when correct. If it doesn't, you haven't reamed or reduced the shank enough.
    - Glue the hammers
        - Set up the jig or plexiglass guide
        - Using the glue applicators, spin the hammer
        - Light pressure is the answer
        - Measure top-bottom, left-right and it works into the right spot without going too far.
        - Hanging a set of hammers might take about four hours
        - Continually check the shoulders and tails with a straight-edge with almost no pressure
        - Check the alignment for square, top and bottom
        - Before the glue hardens, if there are any that are slightly off, take the hammers off, ream them, get the glue off na re-hang them
    - Trim the shank tips
        - 36 grit sandpaper on a disc
        - Clamp the shanks together
        - Saw off the shank tips
        - Do not change the angle of the tail: that is sacred
        - Start at the top and quickly bring it down to where the shank is
            - Freeze your arms and move steadily
- Traveling, Burning Spacing
    - Traveling (shank and hammer moving left or tight as they rise to string) occurs when a flange or center pin is not horizontal
        - Lift the shanks and watch which way it moves
        - Paper the side it moves toward
    - Burning
        - If you see the triangle shrink on one side as it rises, it needs burning
    - Spacing
- Finish up the job
    - Regulate
    - Re-pin everything and weigh it off
    - Voice
    - Sit down and analyze time spent
    - I told you it was a mistake"
    - Where did you make and lose money
    - Record on estimate to assist in making future estimates
    - File every estimate

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