Hammer and Key Weight

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9-year-old yamaha C3
weighed off
Yamaha replacement hammers
No friction
This job took 16-20 hours. This is worth doing for performance pianos.

2 month old Yamaha C3
2.5 grams friction
This piano is the most accurate piano that Roger has come across. It seems to follow Stanwood's chart closely, except for the very high treble.
The average weight of these hammers was just marginally heavier.
There is more friction in the keys. The chart was all over the place.

Friction

The goal is for the pianist to sit down and have the keyboard disappear. When there are variables in the keys, a pianist has to memorize the inconsistencies of a given piano. Musicians recognize the even-ness of an action.
A Samich had 60 grams down weight, which is high friction. We have to work in terms of down weight, which should be around 50. Then the correct up-weight will fall in place, with a difference of about 25 grams. Some pianos without much friction will pick up even more. Some pianos have 60 grams down-weight and will pick up 30. Those pianos will be sluggish and the pick-up will be slow. With 60 down and 40 up is fine – that's 20 grams difference. Friction around 15 grams is OK.

1. First, *analyze the piano* and determine if there is anything we can work with. Some pianos are difficult to work with. Roger has found that Yamaha consistently has the best action to work with. If Roger can get a piano to feel like a Yamaha, then he has reached his goal. Heavy down will make the key leverage wrong. On a Yamaha it will be 1 to 8.5 on a key. Check the key weights and the leads.
2. *Check the action spread*. Set the device at standard distances from whippen center pin.
3. Check how far the *knuckle is from the shank*. Mason Hamlin does 17 mm from the knuckle to the center pin. Most pianos are 16.
4. *Deal with friction.*
   - *Flanges.* The most common friction source is the hammer flange. Push a friction guage against a flange and see how many grams it takes to break the flange into motion. The flange Roger just tested took 2 grams to begin moving. Check the friction in the whippen. Re-pinning alone can add or subtract one or two grams.
   - The highest friction point in an action is the *knuckle*.
   - Polishing the *capstan*s and putting teflon powder on them produce negligible results.
   - Balance & front *rail felts.*
5. *Even out the hammers*. David Stanwood drew up a chart. Take every hammer off the action. Find out how heavy each hammer is. Set the hammer shank on the tower, rest the hammer on the scale and record the weight. Graph these recordings. Asian pianos have hammers in the heavy section, the Yamaha hammers are medium hammers. Square grand hammers would be extremely light. Steinways need 6-8 mm weight in the top six hammers. They are a bit light as they are made.
   There is a ½ inch jump from not to note on the midsection, but at the top there is hardly any change. To excite the strings the amount of mass in the hammer is crucial. Since the strings are pretty much the same length in the top treble, it makes sense that the hammers should be about the same weight. Look at the chart and ask, "what can I do?" Lightening up the shank or hammer more than a gram will weaken the hammer, particularly in the mid-section and the treble. As a rule, most pianos have a

jagged line, so it is better to lighten the heavier hammers than to add more weight to the light ones. To have every hammer exactly the same so the weights are even, take a piece of drill rod, lay it on the chart and curve it to what looks perfect, and draw that line onto the chart, saying, "I want my hammers to be right there." Because there is such a long bore distance in the bass, the weight of these hammers is where it is more because of construction than intent. Sand away to see how far you can go without destroying the hammers in the bass to lighten them up. Lacquer can add .1 gram to the weight.

6. *Remove the hammer weight.* Most of the weight can be removed from the sides. If the hammer gets too narrow, it becomes weaker and might not hit all three strings. Bass hammers are generally wider. Avoid taking too much off the tail. If there is just a little point there it is hard to voice the hammers, and there is less surface to catch on the back-checks. This might also make the hammer strike at an angle. Take some off the inside of the cove about .3 grams, some from the top, and maybe a little felt off in the back up to the staple, but this doesn't look as good. There are going to be a lot of Korean hammers that need all these areas removed. Most gain is from removing the size, the coving and the shanks, and not so much from removing felt. . There is not as much control with a light hammer. Be careful not to go too light, or the hammer will move faster than the string. Roger's hammer that need the most sanding went from 13.0 to 11.6.
7. *Add weight to the hammer.* Most hammers are too heavy. The easiest way to add weight is to use 2-hour epoxy, and apply it with a tooth pick to the back coving area of the hammer. This takes about five minutes to harden so it doesn't run. Epoxy also aids in balancing the hammer more, which provides a good percussion. Sometimes it gets a bit scary to realize how much weight needs to be added. Roger's worst hammer was 8.8 and had to be changed to 9.4, which is about .6 grams of epoxy that he added. Lead looks better, but it takes longer. The weight of the hammer affects the tone.
8. *Key weights.* The weight of the key affects the touch. The factories will say, "this is our experience with these actions." Steinway has both engineered leads made by design first, then they do an individual weigh-off and add weight. The problem with this process is that these piano companies haven't done the hammer chart first. Remember that one gram in the hammer relates to five in the key. Weigh off the key with all the hammers at various weights, this mistake compounds the problem in the key. Because it is difficult to weigh off each individual key with the stack in, there is a way to do it with the stack out. Put a given weight on the back-check, then measure what it takes to balance the key out, to have it go up and down at a certain weight. Record these measurements and put them on a chart. The lead is the same weight on the back of the key all the way up, so we have a constant reference. Don't add weight to the key. So how do we make the chart even? There is more lead in the bass to offset the heavier hammers, and no leads in the treble because the hammers are so thin. Take a ¼" or larger brad point bit and drill the lead out. You gain most from the leads toward the front of the key. Drill out the center of the lead. If that is not enough, take a larger bit and continue. Don't remove more than 50% of the lead so it stays in and doesn't fall out.
9. *Determine what needs to be done.* How much lead needs to be taken out on these keys to make them match my chart? Set the key leads on the back-checks. Pull out the gram weights and measure the three test points. Drill out the leads on the keys and mark on the chart. Make the mark fall on those three notes. With the line as a guide, everything can be put just where we want it. Once the keys are set, they don't need to be weighed off again when installing new hammers. Although we can make our chart any way we want, it is best to make it as close to the factory specs as possible, which is about 50 grams for down-weight.
10. *Summary.* When a piano is evened out, it is perceived as faster and lighter. It feels like a felt touch. It is easy to play softly and quickly. Of course, the piano needs to be well regulated. For example, the weight of heavy hammers can lower the let-off. Allow 16-24 hours for a job like this. Yamahas are quicker, Korean pianos take much longer because they have serious friction problems. Sometimes they need to be re-pinned, there might be rubbing of knuckles, adjacent whippens, etc.