Controlling the touch weight of the upright action (2)

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In the last article, I showed how to control touch using general treatments then explained how touch weight and kinetic resistance affect upright actions. Because the hammer rotates parallel to the ground, the **weight** of the hammer doesn't have a large effect on touch weight. But calculation of the Moment of Inertia (MoI) on all three action parts, (hammer assembly, wippen assembly and key) showed that hammer weight contributes nearly 90% of the MoI at the key.

This month, I will show how to control touch of the upright action by adjusting key leading, action ratio, strike ratio, hammer strike weight and the MoI.

4, Key leading

The majority of modern uprights have rear weighted keys with only few leads. We often find only one lead in back side of the key. This is to keep front of the key up, even when using the soft pedal. With back weighting the balance weight of a key is heavier than in a grand piano. As the front weight of the key is low the key may have a negative balance weight value. Usually a player won't feel an upright touch is heavy, sometimes they actually feel it is lighter than a grand. This is because the MoI at the key is much less than in a grand piano. The sensation of touch is a combination of the touch weight **and** the MoI of the action parts. The action is somewhat heavier measured by static balancing but moves more easily (lighter) as the kinetic resistance (MoI values) are lower.

Adjusting key leads for balancing and the MoI is possible. To increase the key MoI (make the key heavier) you can add the same leads to both side of the key stick at same distance from the balance hole as in fig 6. Using this method, the touch weight is kept the same as it was, but the MoI of the key stick is increased which makes the touch resistance bigger.

(Fig 6) Added key leads to both side of key stick at same distance from balance hole

Reducing the touch weight can be done by relocating the back lead closer to the balance hole and/or you can use a smaller lead. To avoid front weighted keys which "wink" when using the soft pedal, the position of the lead(s) needs careful attention.

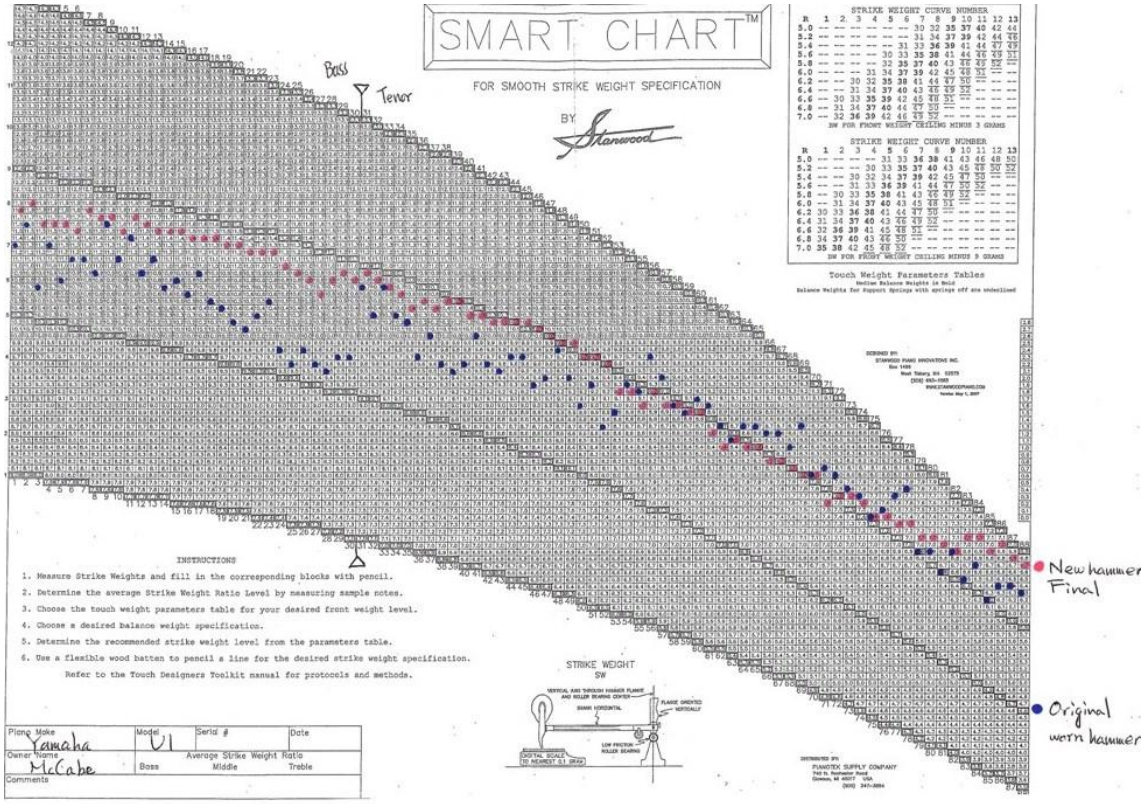
Re-balancing keys to adjust the balance weight can be done in the same way as a grand. It is better to have a heavier standard balance weight value than in a grand piano. Standard balance weight for an upright would be 40g to 45g.

5, Hammer strike weight (HSW)

HSW of upright actions has not often been discussed, however adjusting the HSW gives technicians and pianists two big benefits. One is the adjustment of the weight sensation. Because HSW is the largest component in both static and kinetic touch weight, even a very small change in the HSW makes a change in the touch. Naturally, complete evenness of the HSW curve in a piano gives a smooth seamless touch throughout all registers.

An additional benefit is evenness of tonal quality. With smoothly adjusted hammer mass, the strike force will be even and tonally smooth. The bass especially can usually be improved. The shorter length bass hammers are much lighter than the neighbouring tenor hammers.

Using Stanwood Smart Chart ® makes this easy.



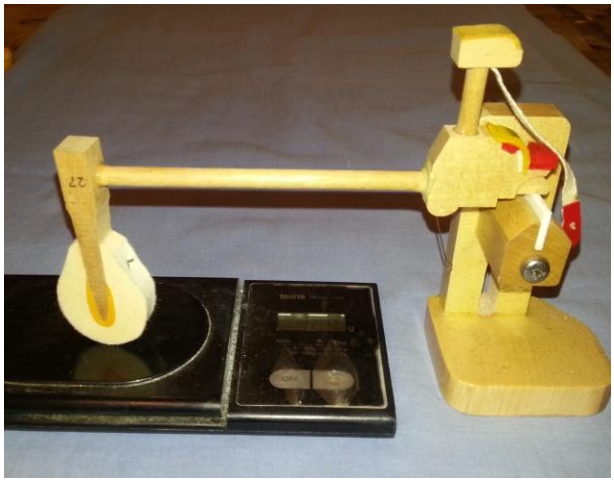
(Fig 7) Plotted smart chart of an upright piano (Blue: original hammers, Pink: New hammers, HSW adjusted)

For example see Fig 7, a Smart Chart of a Yamaha U1 on which I installed a new set of hammers. The original bass hammers (blue on chart) were lighter than the trend line of tenor and treble hammers. The leading in the keys was reasonably consistent but the balance weight of this piano was not consistent at all, so the touch of the piano couldn't be even. After installing new hammers the HSW was adjusted, as shown on the chart in pink. The touch and tonal evenness were much better than the original, and not just because of the new hammers.

Measuring the HSW of an upright hammer assembly can be done several ways:

1, If the hammer has a butt plate, the center pin groove of the hammer butt can be put on the edge of the measuring jig as in Fig 8. Or place the butt plate on the edge of the jig in line with the center pin groove.

2, If the hammer assembly has been removed from the action, regardless of whether the hammer assembly has a butt plate or pinned flange, measure by putting the flange on the jig in line with the center pin. The HSW decreases only a little measured this way , typically around 0.1g, (compared with measuring without the flange).



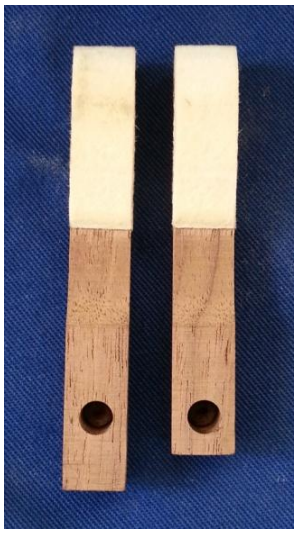
(Fig 8) Measuring HSW of upright hammer assembly without flange

I don't think that the exact method of measuring HSW is as critical as being absolutely consistent with your measuring. We are finding practical solutions, making an action lighter or heavier for the customer in comparison with how it was previously. If the customer is happy with the final result we have been successful.

For the actual adjustment of HSW in an upright, I avoid tapering the hammer moulding (as we might do on a grand piano). This is partly because the upright hammer is more visible to the customer (and perhaps other technicians), unevenly tapered hammers are not attractive even if they do achieve a smooth HSW weight. Instead, lightening hammers can be done by shortening the tail, removing timber from the moulding below the hammer felt, and boring holes in the underside of the hammer head. The reduction in tail length should be same

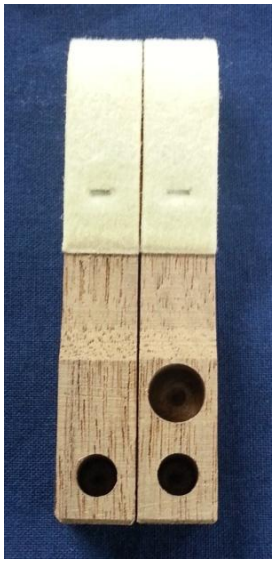
within each section for cosmetic reasons. The tenor section and treble sections can have different lengths, but all hammers within each section should be the same length. The minimum distance between the back of the hammer shank and hammer tail should be no less than 3 mm. The rest of tail can be cut off. A decrease of about 0.1g of HSW per 1mm is normal. This process can be done with existing hammers as well as with new hammer heads (Fig 9 & 10).

(Fig 9) Cutting hammer tail on a band saw. With new hammers shorten the tail before gluing.



(Fig 10) Shortened hammer tail (Left: original, Right: shortened.)

The hammer head can be bored with a 10 mm drill from bottom side of hammer head. This removes about 0.2g. Obviously the hole shouldn't go through the top surface of hammer moulding. Also keep enough distance from shank hole to avoid weakening the hammer structure (Fig 11). This is easier to do with new hammers. Using CA glue to dope the weight reducing hole adds more strength and avoids breakages.



(Fig 11) Bored hammer head to reduce HSW (Left: original, right: reduced weight)

We can also sand off the corners of the hammer head. Use a router with jig, or cut them with a band saw and clean up by hand filing or sanding for a good appearance.

If you want to increase the HSW, you can install lead wire in the hammer heads, or add weight to the underside of the hammer moulding.

We have limited ways to adjust the HSW and a small adjustment range so we may not be able to achieve a perfect target HSW curve, but we can certainly improve the situation with these techniques.

6, Pilot – wippen heel connection

Traditionally we have adjusted the pilot position by bending its wire to make the touch heavier or lighter. Bending the wire backward makes the touch heavier, bending it forward makes the touch lighter (Fig 12). This works because it changes the action ratio, strike ratio and the linked ratio of the MoI at the key.

If the piano has a pilot wire, it is quick and easy to adjust for and aft within the wippen heel cloth. You may need to make the heel cloth wider if you needed adjust beyond the wippen heel cloth.

(Fig 12) Pilot is set forward by 3mm from the centre of the heel cloth,

From trials with a Yamaha U3: When the pilot was moved backward by 3mm, balance weight increased 4-6g. When it was moved forward, it decreased by 4-6g. These amounts will depend on the individual action. The action ratio is changed by this adjustment, the regulation, specifically depth of touch, after touch and hammer checking, need to be refined after doing it.

Adjusting pilot is very easy to do at the customers. Make samples at both end of each section then adjust the rest with a ruler or straight edge to making sure all pilots are exactly aligned. This might take 10 minutes, (be careful to not put the pilots beyond the end of the wippen heel felt).

If a capstan screw is used, it is possible, but not as easy to move its position. Relocate it by plugging the hole and re-boring the new position. This is obviously a workshop job.

7, Key balance punching cloth

According to Stanwood, cutting the balance punching cloth in half and putting in on the back side of balance pin makes touch weight lighter. Putting it on the front side makes it heavier. Huggins wrote about this in his article “Affordable Vertical Touchweight Refinement” (page 28-32, June 2012, Piano Technicians Journal).

This modification changes the action ratio and strike ratio. The key ratio changes as if the pivot of key moved about 3mm. From my trials, the strike ratio changed by 0.1-0.3 so the balance weight changed about 2-3g.

There are at least two ways of doing this:

- Cut punching glued to bottom side of the key (Fig 13).
- Glue punching to paper washer (Fig 14) etc.

Choose the best method for your situation.

(Fig 13) Cut punching cloth glued to the key

(Fig 14) Cut punching cloth which is glued to thin paper washer (pink in the photo)

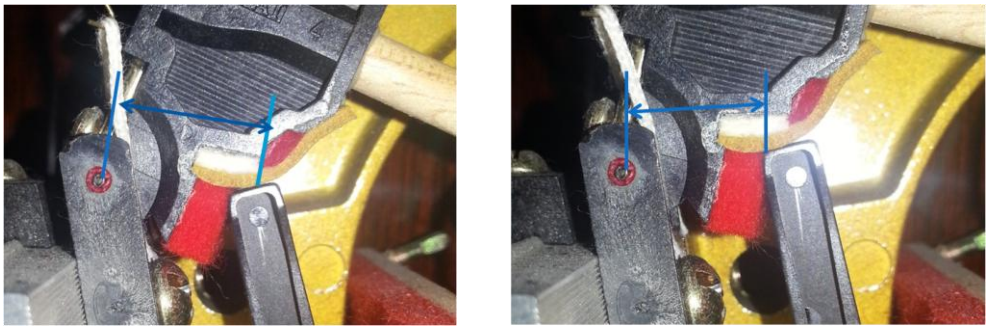
Because the strike ratio of upright pianos is much smaller than in grand pianos, the effect is less than in grand pianos, but it is still a useful option to modify the touch weight.

8, Condition of the butt felt (or cushion)

Worn or uneven (or a missing) butt felt may cause a heavy touch weight. This is because the butt felt thickness fixes the input distance of the hammer assembly which affects the action ratio, strike ratio and the linked MoI value at the key. If this felt is heavily compressed the jack to hammer butt center dimension is decreased so the touch becomes heavier, in the same way that a shank roller on a grand action which is closer to the shank centre causes a heavier action. In addition, as the jack needs to travel a longer distance to be let off from the butt, it makes the touch feels heavier.

It is worth noting that the actual contact point between jack and butt leather is not the back corner of the jack in its rest position. At rest the contact point between the jack and butt leather is about 2-3 mm forward from back edge of the jack (see Fig.15 left). During the stroke, the contact point moves to the back edge of the jack because of the rounded shape of the butt leather (Fig 15 right). If you measure down weight on an upright action, you may note that initially the key moves down quickly then slows down. The movement of the contact point causes the increase in weight and resistance. The change in distance between

these two points may be small, but it changes the action ratio during the stroke, comparable to the effect of moving the hammer roller 1 mm on a grand.



(Fig. 15) Jack at the rest position (left) and moved contact point after a little movement (right)

If the butt felt is heavily compressed or uneven, (or missing) the distance between the jack contact point and the butt center shortens and causes a heavier touch.

It is possible to make the touch lighter by replacing butt felt with a slightly thicker felt, but in a trial an increase in butt felt of 1mm reduced the touch weight only 1-2g. Work in this area is obviously more normally part of a repair but you should carefully observe the relationship between butt leather and jack position when selecting butt felt thickness. Obviously, overly thick felt here is also to be avoided as it will cause loss of energy transmission, for example inefficient let off.

Butt felt should be the correct thickness as it fixes the contact distance between jack and butt. We need to be aware of this when assessing touch problem.

Conclusion

There are more upright pianos in the field than grand pianos. We should make sure our customers are aware that touch adjustment at a reasonable cost is possible on upright pianos. If the cost of the work is a problem some simple adjustments can be made in little time. We might adjust the pilot wires for all notes in 10 minutes. Adjusting the position of the tapes can also be done in just a few minutes.

Beyond these adjustments we can improve the regulation at relatively little cost. Additionally we can offer very refined touch control when replacing hammers. This is a really great opportunity to give our customers better performance from their instrument. New hammers with fully adjusted HSW, voiced, keys rebalanced to a specific balance weight, adjusted MoI of the key, an exactly regulated action, this will give your customers a very high level upright performance piano.

Upright pianos do have less refinements available than grand pianos, but they also have commonly overlooked possibilities for us to improve the performance level. I hope this

article helps fellow technicians who wish to explore and improve the performance possibilities of upright pianos for their customers.