Standard Protocols of the New Touchweight Metrology

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In June of 1996, I published "The New Touchweight Metrology" in the *Piano Technicians Journal.* That paper described the "Equation of Balance" which links newly defined weight and weight/ratio components to the traditional touchweight parameters of up weight and down weight and makes possible the calculation of the overall weight ratio in the grand key. Since then, the methods for taking these measurements have been improved and refined and new components have been discovered. With the upsurge of interest in their use in the trade, it is important that we all speak the same language and follow a standard protocol so that anyone taking these measurements will come up with same repeatable results. The purpose of this paper is to publish the current protocols and notation of the New Touchweight Metrology.

Protocols for measuring Strike Weight (SW), Front Weight (FW), and Key Weight Ratio (KR) have been upgraded. New measures called Shank Strike Weight (SS) and Key Friction Weight (KF) are added to the Metrology. The additional calculated value called Support Spring Balance Weight (BWS) is also described.

The setup for Strike Weight (SW) was previously described with the hammer resting facedown on the scale pan with the hammer oriented vertically. The new protocol calls for resting the hammer tail on the scale pan with the hammer facing up. The flange is oriented vertically and rests on a low-friction roller bearing as before. The height of the roller is set so that the shank is oriented horizontally. This is done with the aid of a bubble level resting on the top surface of the shank (see Fig 3). This method achieves improved repeatability of the results, and requires less operator skill.

The new component called Shank Strike Weight (SS) is the weight of the shank taken at the strike line radius with the shank set up as for taking Strike Weight (see Fig 2). Shank Strike Weight (SS) and Hammer Weight (HW) (see Fig.1) are the two components of Strike Weight (SW). Strike Weight

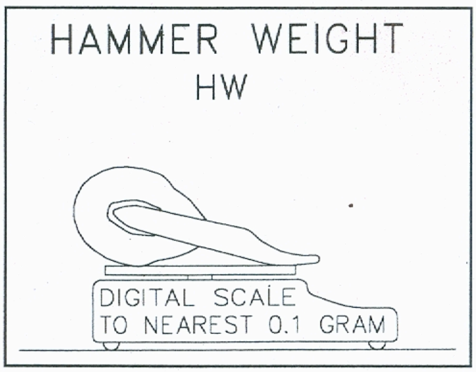


Figure 1

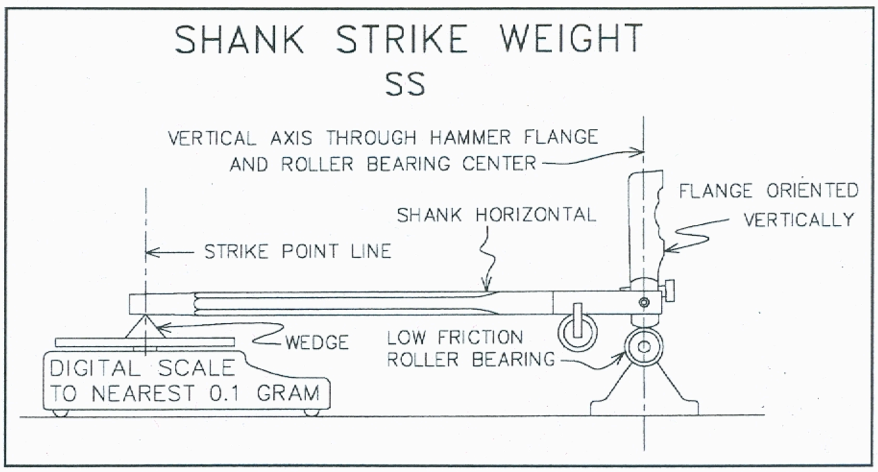


Figure 2

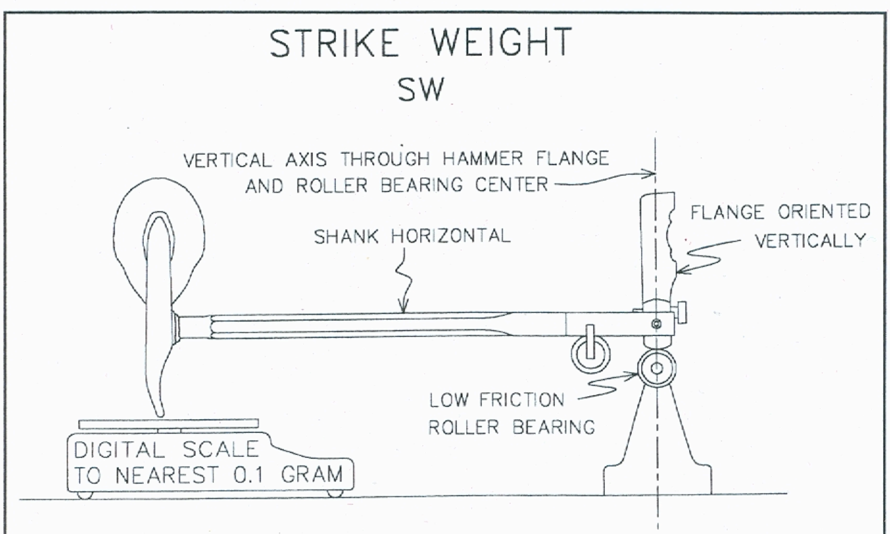
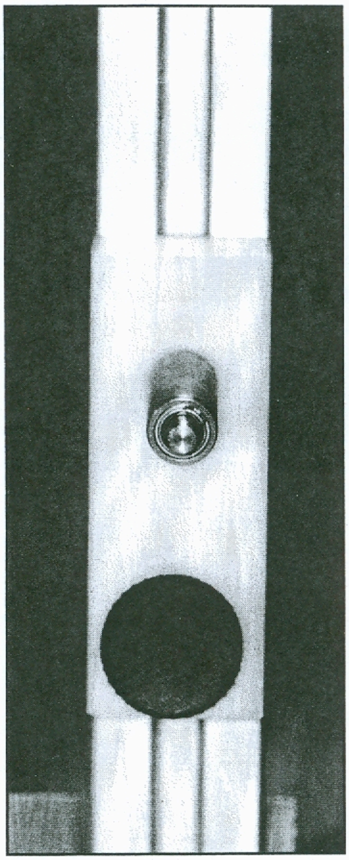


Figure 3

may be determined by adding them together.

The formula is: SW = HW + SS

Conversely, Hammer Weight (HW) may be expressed in terms of Strike Weight (SW) and Shank Strike Weight (SS). **The formula is: HW = SW - SS**



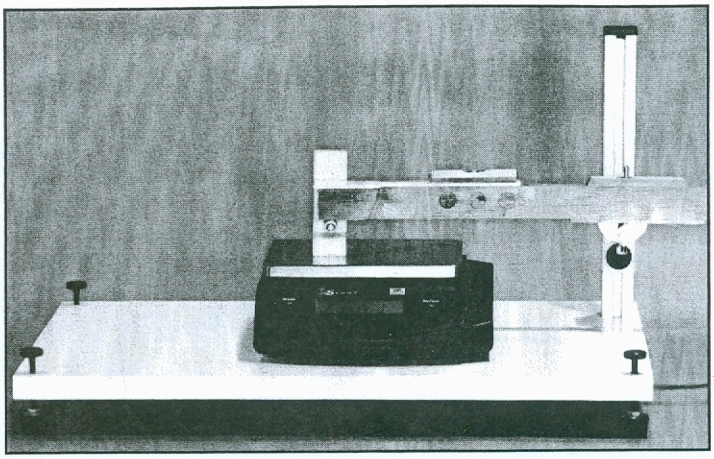


Photo 1** (LEFT) **— Tooling for Front Weight measurement, showing roller bearing and thumbscrew for adjusting height. Photo 2** (ABOVE) **— Front Weight measuring setup.

Tooling and procedures for Front Weight (FW) setups have undergone some exciting changes. In June, 1996 the method called for pivoting the key on a simple wedge. Alignment of the balance hole on the wedge was confirmed by sighting down through the balance hole to see that the knife-edge crosses the hole. This takes time and concentration in setting the key properly and time is wasted when some keys tend to fall over. The ideal tooling shown here is designed by David C. Stanwood of Stanwood Piano Innovations Inc. and developed by Bob Marinelli of Pianotek Supply Company. It has evolved to incorporate a roller bearing attached to a block that may slide up and down a slotted aluminum tower whereby the height is easily adjusted and set with a thumbscrew (see Photo 1). The tower itself sits on a 12" x 18" base board, which doubles as a work area for the digital scale. Leveling feet provide a firm level work area on any surface (see Photo 2). The wedge jig for measuring Front Weight (FW) is attached to the roller bearing on the tower. The jig uses a section of 1" aluminum rod with a 3/8" square section acting as the wedge (see Photo 3). The wedge is fastened by a shaft into the larger rod such that the edge of the wedge lines up on the center of rotation of the larger rod. The assembly is fastened over the roller bearing on the tower with a lightweight set screw. An extra long balance-rail pin passes vertically through the edge of the wedge and is fastened with a set screw. The balance-rail pin is set fairly high on the wedge so that it just remains vertical when left on its own. (If set too high, the assembly will flop down.) The wedge holding the pin may be rotated slightly as needed to have the pin come to rest in a vertical position. Once set up, the key is simply placed on the balance-rail pin (see Photo 4). The balance-rail pin is interchangeable to accommodate various balance-rail pin sizes. By this design, keys made with any balance-rail pin angle may be accommodated and keys will never tip over when being measured.

The set up for Front Weight (FW) was previously described as tipping a key onto the scale with the key oriented in a horizontal attitude similar to when the key is at rest in the piano. The updated standard protocol now calls for the key to be set in a horizontal attitude with the aid of a bubble level (see Photo 2). The results are essentially the same as before and the guesswork of the horizontal angle is eliminated.

An additional protocol solves a Front Weight (FW) measuring problem that sooner or later occurs: measuring keys with negative Front Weight (FW). This means the key is heavier on the backside and it won't stay down on the scale pan jig. The solution is to place a dummy weight on the scale pan before setting up the key. The scale is set to zero with the dummy weight and roller jig on the pan. Then the key is placed on the roller jig for measuring and the dummy weight is then placed on top of the key over the roller bearing to hold the key down onto the scale jig. The Front Weight (FW) is read directly off the scale as a negative value.

The protocol for measuring Key Weight Ratio (KR) was previously described using a 100-gram weight set at the capstan with a heavy weight holding the front of the key down on the scale jig. This

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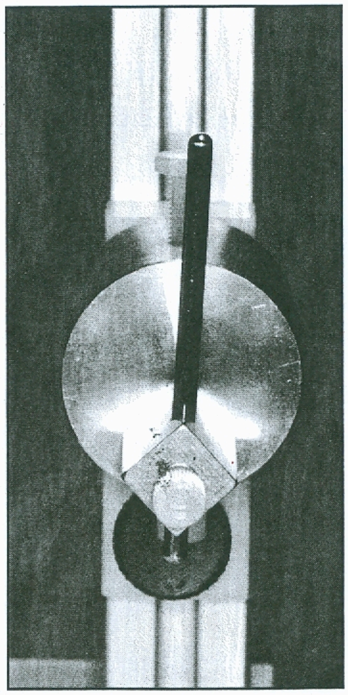

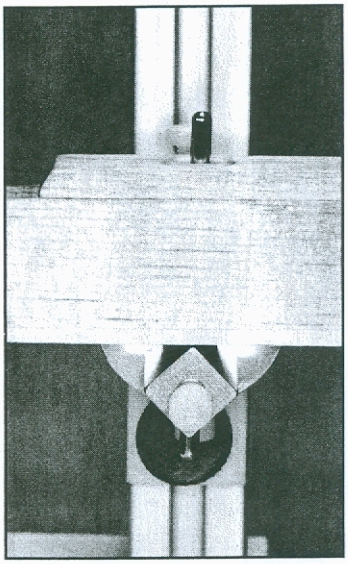

Photo 3** (LEFT) **— Close-up of wedge jig for Front Weight measurement. Jig is fastened to roller bearing from photo 1 using set screw shown behind balance-rail pin. Photo 4 —** (ABOVE) **Key shown resting on wedge jig.

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gave results accurate to three decimal places, which is more accurate than needed. The revised protocol calls for setting up the key as for measuring Front Weight (FW). The digital scale is then set to zero. With the scale set to zero, a 10-gram weight is placed on the back of the key, centered on a vertical axis which passes through the capstan/heel contact point. This gives results accurate to two decimal places. For instance, if the scale reads -5.5 the Key Weight Ratio (KR) would be 0.55.

The new measurement called Key Friction Weight (KF) tells us precisely how much of the Friction Weight is from the key bushings. Place the key on the front weight jig and follow the protocol for measuring negative Front Weight (FW). With the key on the jig, place temporary weights on top of the key and slide them back and forth until a position is found that makes the Front Weight (FW) zero. Then, without disturbing the position of the temporary weights, place the key back on the key frame and push the back of the key down onto the back rail cloth. Then find the minimum amount of weight placed on the front of the key at the Measuring Point that causes the key to drop (Photo 5). Another way is to place the key on the frame and attach a key leveling lead to hold the back of the key down. Then measure Up Weight and Down Weight (with stack off) and apply the formula (DownWt -UpWt)/2. The value found is Key Friction Weight (KF).

A new term called Support Spring Balance Weight (BWS) describes the effect that the wippen support spring has on the balance weight of the key. It is essentially the difference between the Balance Weight (BW) with the support spring disengaged and engaged. Engaging the support spring equally reduces Up Weight (U), Down Weight (D) and Balance Weight (BW). So, measuring any of these values before and after engaging the spring will give you the Support Spring Balance Weight (BWS). I like to use Up Weight (U) simply because it's the easiest and quickest to measure. The preferred protocol is to measure the Up Weight (U) with the support spring disengaged. Then the support spring is engaged and Up Weight (U) measured again. The difference between the two values is the Support Spring Balance Weight (BWS) which tells how hard the spring is working.

The purpose of this article is to update and standardize the measuring protocols of the New Touchweight Metrology. It lays the groundwork for upcoming articles which will describe the meaning and application of all these new measures, based on studies carried out over the last decade.

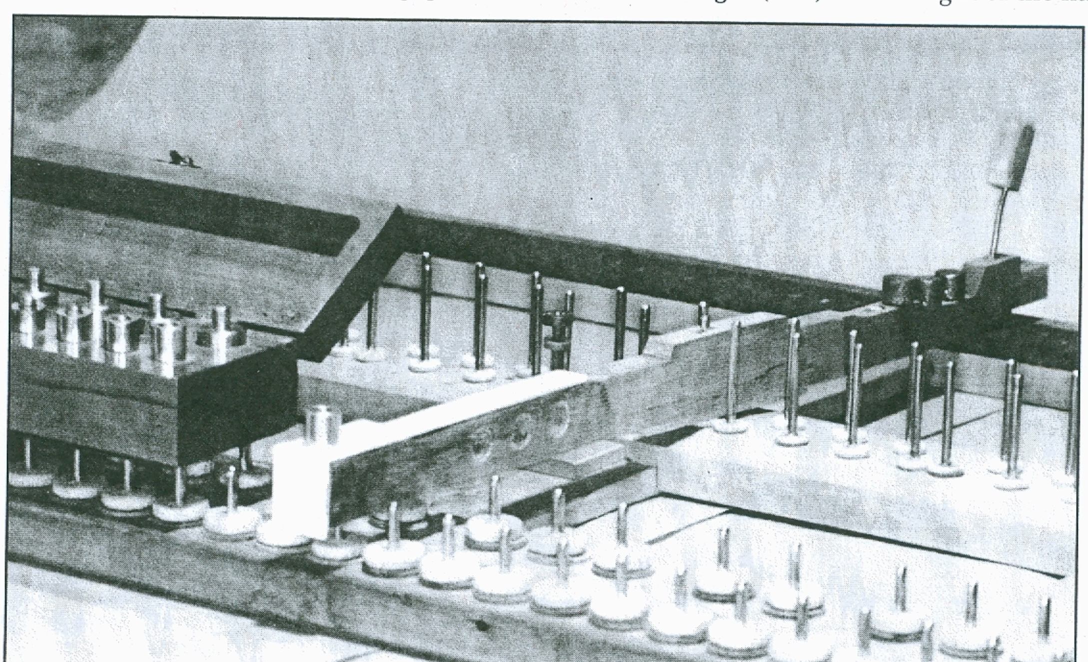

Photo 5 – Measuring Key Friction Weight.

Glossary

Terms and abbreviations used in the New Touchweight Metrology:

Balance Weight (BW) - The amount of weight placed on the Measuring Point that causes the key to be balanced.
Found as: BW = (D + U)/2

Down Weight (D) - The minimum amount of weight, to the nearest gram, placed on the measuring point that causes the key to drop while maintaining a slow controlled motion of the hammer.

Friction Weight (F) - The minimum amount of weight added to the Balance Weight that causes the key to drop while maintaining a slow controlled motion of the hammer or the minimum amount of weight taken away from the Balance Weight that causes the key to rise while maintaining a slow controlled motion of the hammer.
Found as: F = (D - U)/2

Front Weight (FW) - The amount of static weight, to the nearest 0.1 gram, that the level key, tipped on its balance-pin point, exerts at the measuring point.

Key Friction Weight (KF) - A component of Friction Weight which is the minimum amount of weight, to the nearest gram, placed on the measuring point of a key that causes the key to fall, with the Front Weight (FW) set to zero with temporary weight and with the key on its frame and the stack removed.

Hammer Weight (HW) - The weight of the hammer with shank removed.

Key Weight Ratio (KR) - The ratio of downward force on the capstan/heel versus the corresponding upward force at the measuring point as translated through the key or the amount of weight at the measuring point needed to balance 1.0 grams of weight at the capstan/heel contact point.

Measuring Point - The datum point on the top of the key 13mm or 1/2" back from the front lip of the key. Weights are centered on this point when measuring Up Weight and Down Weight. When measuring Front Weight (FW) the key rests on a roller bearing on the scale pan. The point at which the front of the key rests on the bearing is directly below the Measuring Point. Any measures that contain the term Balance Weight refer to static up or down forces at the front of the key through the Measuring Point.

Shank Strike Weight (SS) - The amount of weight to the nearest 0.1 gram of the shank, pivoted without friction at the hammer center with shank level, measured at the strike line radius.

Strike Balance Weight (SBW) - The upward static force at the Measuring Point resulting from the static weight of the hammer and shank, leveraged through the shank, wippen and key: Found as: TBW - WBW.

Strike Weight (SW) - The amount of weight to the nearest 0.1 gram of the shank and hammer, pivoted without friction at the hammer center with shank level, measured at the strike line radius.

Strike Weight Ratio (R) - The ratio of downward force at the hammer versus the upward force at the measuring point as translated through the shank, wippen and key, or the amount of weight placed on the measuring point needed to balance 1 gram of Strike Weight (SW). Found as: SBW/SW.

Support Spring Balance Weight (BWS) - The difference between the balance weight with the wippen support spring disengaged and with it engaged.

Top Action Balance Weight (TBW) - The combined upward static force at the measuring point resulting from the static weight of the wippen leveraged through the key and from the static weight of the hammer and shank, leveraged through the shank, wippen and key. Found as: BW + FW.

Up Weight (U) - The maximum amount of weight, to the nearest gram, placed on the measuring point that the key can lift while maintaining a slow, controlled motion of the hammer.

Wippen Balance Weight (WBW) - The upward static force at the measuring point resulting from the static weight of the wippen leveraged through the key, found as: KR x WW.

Wippen Weight (WW) - The amount of weight, to the nearest 0.1 gram, of the level wippen, pivoted without friction at the wippen center, and measured at the capstan/heel contact point.