ACTION RATIO CHART			AR = Hammer Rise (mm) / 6
29mm = 4.83	32mm = 5.33	35mm = 5.83	38mm = 6.33
30mm = 5.00	33mm = 5.50	36mm = 6.00	39mm = 6.56
31mm = 5.17	34mm = 5.67	37mm = 6.17	40mm = 6.67

USING THE ERWIN ACTION RATIO GAUGE

The Erwin Action Ratio Gauge is a diagnostic tool that can help precisely determine the desired weight of new hammers in a grand piano action. The gauge determines how far the hammers rise per unit of key movement.

To use, simply place the gauge at the front of the key to be studied, and the gauge will depress the key 6mm. The hammer rise is measured in millimeters from the top of a neighboring hammer to the top of the raised hammer. If the hammer rises 36mm, and the key is depressed 6mm, dividing 36 by 6 gives us an action ratio (AR) of 6:1.

6:1 action ratios are quite common in many old Steinways, Baldwins and Mason & Hamlins. These actions typically used light hammers. If heavier hammers are installed, each additional gram of hammer weight would equal six more grams of down weight. If you are satisfied with the AR, and also with the touch weight, it is best to duplicate the shanks and flanges, maintaining the same knuckle placement, and also keep the same hammer weight. It is important to measure the weight of several original hammers using a gram scale. When changing hammer weights in a grand action, the action ratio can be altered by changing knuckle distance or capstan placement.

Suggested Measuring Procedure:

Step 1. Measure the action ratio of all 'C' and 'C#" notes.
Step 2: Measure the down weight and up weight of all 'C' and 'C#" notes.
Step 3: Remove each of the "C" and "C#" hammers and record their weights.
Step 4: Determine if you wish to change down weight and up weight.
Step 5: Using the action ratio, determine the desired weight of the new hammer.

Interpreting the measurements (example):

1. The action ratio measures at 5.7 to 1.
2. The down weight is 58g. The up weight is 28g.
3. The existing hammer weight is 9.0g at note C0.
4. You decide that you want a down weight of 54g and up weight of 24g.
5. For the desired 4g change, divide the 4 grams by the 5.7:1 action ratio.
6. The new hammer at C0 must weigh 0.7g less than the old one.
7. Subtract 0.7g from the original 9.0g hammer.
8. Therefore, the new hammer must weigh 8.3g.
9. If a 9g hammer is desired, then increasing knuckle distance from the center pin by 1 mm (.040") will decrease the action ratio by 0.4, making the new ratio 5.3.
10. A 2 mm change in the capstan placement will lower the ratio by another 0.4.

Down and up weight measurements are important, but they do not tell us anything about inertia, which is related to the overall mass in the action, and impacts the touch of the keyboard beyond pianissimo levels.

Friction also enters the equation, and the sample keys from which down and up weight measurements are taken should be free of stiff center pinning or tight key bushings. Flattened knuckles also increase friction. Wippen assist springs add another variable, which can interfere with the accuracy of our measurements and results.

Observing key leading patterns is important, as the placement and quantity of leads is critical to optimizing the touch of the piano without unnecessary inertia. Key leading will often have a 3,2,1 pattern from bass to treble.

Balance weight is also important to consider. It is the down weight plus the up weight added together, then divided by 2.

$$BW = \frac{(DW+UW)}{2}$$

For example, if the down weight is 50 and up weight is 24, the two added together =74, which divided in half is 37g. A balance weight close to 37g is what many pianists find optimal. Concert grands can often handle up to a 40g balance weight. Balance weights over 40 (too heavy), or under 35 (too light) will typically need correction.

Action regulation parameters can also confirm the AR. For example: You can use sample keys to set an accurate key dip of 10 mm at the key pin. Set a hammer blow distance of 45 mm (1.75"). Set a 1.5mm let off and 1mm drop. Depress the key slowly through let off and observe the amount of aftertouch. Shallow key dip and long hammer blow distances confirm a very high AR (6:1 or higher), requiring lighter hammers. Conversely, a short blow distance and deep dip confirm low AR (5:1 or less), which can support a heavier hammer weight.

If moving the knuckle placement does not provide enough improvement to the AR, then moving the capstans toward the pianist, or installing a corrected keyset are more advanced options to consider. We routinely move knuckles to 17mm and capstans forward on all Teflon era pianos to achieve a 5.5 ratio.

Observe if the jack is escaping by a large margin or not at all. If there is too much aftertouch, a longer blow distance may be required to limit jack escapement. (Making the key dip shallower would also reduce jack escapement). If there is not enough aftertouch, this could be remedied by a shorter blow distance (or deeper key dip).

Back of the key height determines damper lift height, back check height and amount of felt under the balance rail. It also determines the thickness of the felt and paper punchings on both rails, and the front key height.

Key height must be set so the key fits under the fallboard, but not above the key slip.

Measure string heights in each section. This is important for calculating blow distance. If the pinblock is replaced, the plate must be relocated at the same height so the string plane is reproduced, and the action doesn't drag on the drop screws.

Measure hammer center pin heights. The string height minus the hammer center pin is the hammer's bore distance.

Action spread. Measure the distance between the hammer and wippen center pins. This distance is commonly 111.5 mm to 114 mm

Wippen to capstan intersect. The distance from the wippen center pin to the center of the capstan contact point is commonly 66mm when action geometry is set up correctly. Almost all wippens measure 99 mm from wippen center to jack center pin, making the intersect point 2/3 the length of the wippen lever.

Measure Hammer distance. Measure from the hammer flange center pin to the center of the molding. On most Steinways and many others, it is 130 mm (5-1/8") but not always.

Hammer lines are not always straight. Hammers in the 5th & 6th octave of all vintage Steinways benefit tonally in both power and sustain from a slightly curved strike line.

The convergence line is drawn from the wippen center pin to the bottom of the balance pin with the parts at half travel. Ideally, this line should pass through the contact point between the capstan and wippen cushion.

Measure wippen flange center pin height. This can vary and sometimes action elevation changes are required.