

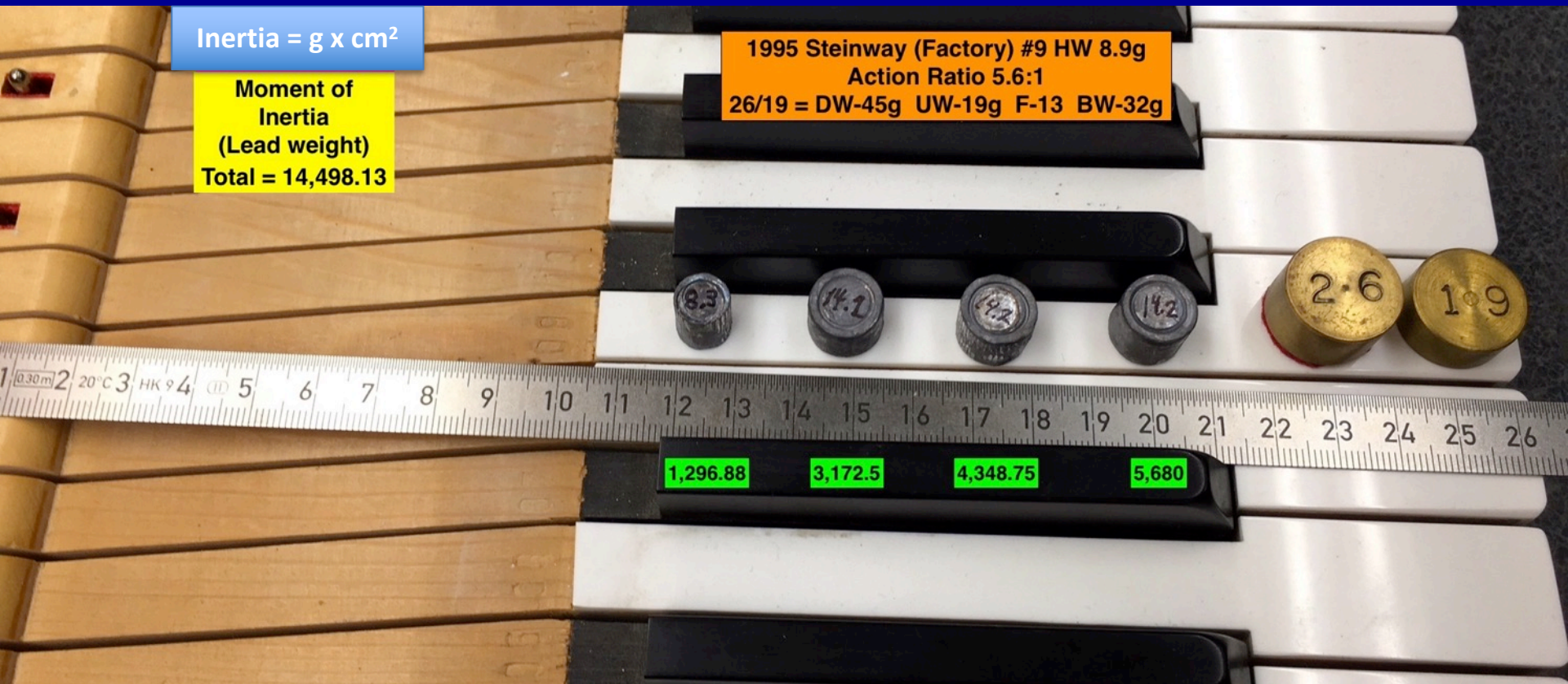
# Grand Balancing Act Act II

## Period 2 – Part 2

PTG Annual Convention  
Tucson, AZ  
2019

# 1995 Steinway B – Note #9

DW = 45g - UW = 19g  
Balance Weight 32g – Friction 13g



Original Hammer Weight – 8.9g  
Action Ratio 5.6:1



$\text{Inertia} = g \times \text{cm}^2$

$\text{Moment of Inertia} = 11,143.8$

Note #9 HW 9.6g BW 37g 16/29



1,400

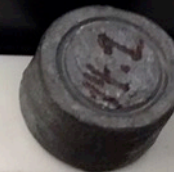
4,103.8

5,640

$\text{Inertia} = g \times \text{cm}^2$

$\text{Moment of Inertia} = 10,851$

Note #9 HW 9.6g BW 37g 16/29



2,016

3,195

5,640



Inertia =  $g \times cm^2$

Moment of Inertia  
= 9,584.7

Note #9 HW 9.6g BW 37g 16/29



298.8

2,016

3,195

4,074.9

Inertia =  $g \times cm^2$

Moment of Inertia  
= 8,566.3

Note #9 HW 9.6g BW 37g 16/29



1,181.25

3,281.25

4,103.8



Inertia =  $g \times ccm^2$

Moment of Inertia  
= 7,902.66

Note #9 HW 9.6g BW 37g 16/29

101.66

518.4

1,134

2,044.8

4,103.8

Inertia =  $g \times cm^2$

Moment of Inertia  
= 7,178.76

Note #9 HW 9.6g BW 37g 16/29

224

587.26

1,150.2

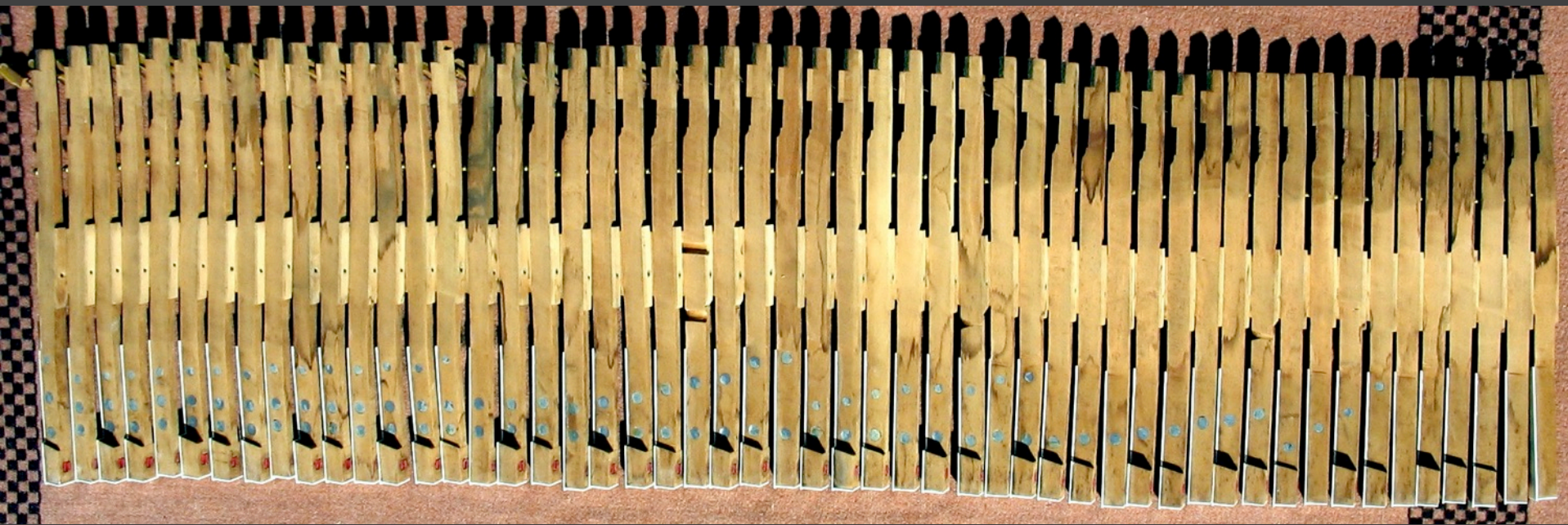
2,044.8

3,172.5

My Simple Inertia Study  
Conclusion Which Comes From  
Experiencing the “FEEL” of  
Actions Where I have  
Made Changes To The  
Front Lead Position (and other  
action components),  
AND Customer Response



- The front lead has the most inertial significances on dynamic touch weight.
- Understanding this fact and establishing the consistent front position of the leads is part of what yields best touch weight results.









Piano/Model Steinway D Serial# \_\_\_\_\_ Date: June 2017

Owner Info: [Name] \_\_\_\_\_

Hammer Type: [Original] \_\_\_\_\_ [New Hammer Type] \_\_\_\_\_

(For Hammer Installation) [O] Original [R] Raw [F] Final [SW] ShankWgt [HW] HammerWgt

(For Balance Weigh-Off) [DW] DownWgt [UW] UpWgt [BW] BalanceWgt

| (For Balance Weigh-Off) |      | [OW] Down Wgt |          | [UW] Up Wgt |      | [BW] Balance Wgt |      |      |          |     |      |
|-------------------------|------|---------------|----------|-------------|------|------------------|------|------|----------|-----|------|
| PW/UW                   | f    | BW            |          | f           | BW   |                  |      |      |          |     |      |
| 1 23/31                 | 11.5 | 42.5          | 23 19/24 | 9.5         | 32.5 | 45 14/25         | 7    | 32   | 67 17/36 | 8.5 | 44.5 |
| 2 26/29                 | 13   | 42            | 24 22/22 | 11          | 33   | 46 19/34         | 9.5  | 43.5 | 68 22/36 | 11  | 47   |
| 3 16/31                 | 8    | 39            | 25 25/26 | 12.5        | 38.5 | 47 15/34         | 7.5  | 41.5 | 69 12/39 | 6   | 45   |
| 4 17/32                 | 8.5  | 40.5          | 26 19/27 | 9.5         | 36.5 | 48 15/35         | 7.5  | 42.5 | 70 14/42 | 7   | 49   |
| 5 17/30                 | 8.5  | 38.5          | 27 22/22 | 11          | 33   | 49 15/38         | 7.5  | 45.5 | 71 12/38 | 6   | 44   |
| 6 27/25                 | 13.5 | 38.5          | 28 23/21 | 11          | 32   | 50 14/37         | 7    | 44   | 72 10/35 | 5   | 40   |
| 7 29/30                 | 14.5 | 44.5          | 29 31/18 | 15.5        | 33.5 | 51 18/39         | 9    | 48   | 73 10/37 | 5   | 42   |
| 8 30/21                 | 15   | 36            | 30 15/32 | 7.5         | 39.5 | 52 22/39         | 11   | 50   | 74 12/35 | 6   | 41   |
| 9 26/21                 | 13   | 34            | 31 17/24 | 8.5         | 32.5 | 53 17/36         | 8.5  | 44.5 | 75 14/36 | 8   | 44   |
| 10 21/26                | 10.5 | 36.5          | 32 20/28 | 10          | 38   | 54 18/39         | 9    | 48   | 76 12/34 | 6   | 40   |
| 11 18/34                | 9    | 43            | 33 23/24 | 11.5        | 35.5 | 55 18/39         | 9    | 48   | 77 15/38 | 7.5 | 45.5 |
| 12 18/37                | 9    | 46            | 34 12/24 | 6           | 30   | 56 17/35         | 8.5  | 43.5 | 78 15/33 | 7.5 | 40.5 |
| 13 16/33                | 8    | 41            | 35 15/23 | 7.5         | 30.5 | 57 16/32         | 8    | 40   | 79 15/35 | 7.5 | 42.5 |
| 14 21/23                | 10.5 | 33.5          | 36 14/23 | 7           | 30   | 58 14/39         | 7    | 46   | 80 15/35 | 7.5 | 42.5 |
| 15 19/33                | 9.5  | 42.5          | 37 19/24 | 9.5         | 33.5 | 59 16/35         | 8    | 43   | 81 12/37 | 6   | 43   |
| 16 23/28                | 11.5 | 39.5          | 38 17/28 | 8.5         | 36.5 | 60 14/41         | 7    | 48   | 82 14/34 | 7   | 41   |
| 17 18/29                | 9    | 38            | 39 18/26 | 9           | 35   | 61 18/34         | 9    | 43   | 83 15/36 | 7.5 | 43.5 |
| 18 25/25                | 12.5 | 37.5          | 40 18/25 | 9           | 34   | 62 16/32         | 8    | 40   | 84 12/38 | 6   | 44   |
| 19 18/30                | 9    | 39            | 41 15/32 | 7.5         | 39.5 | 63 14/40         | 7    | 47   | 85 12/38 | 6   | 44   |
| 20 26/27                | 13   | 40            | 42 18/28 | 9           | 37   | 64 15/36         | 8.5  | 43.5 | 86 10/36 | 5   | 41   |
| 21 22/24                | 11   | 35            | 43 10/29 | 5           | 34   | 65 17/33         | 8.5  | 41.5 | 87 16/34 | 8   | 42   |
| 22 20/27                | 10   | 37            | 44 14/31 | 6           | 37   | 66 21/32         | 10.5 | 42.5 | 88 16/37 | 8   | 45   |

NOTES: #29 - High friction → ProTek flange 20/23

Action To Shop For Balancing Only (No New Parts)









# Steinway Style IV Pattern Leading





# Steinway B Pattern Leading





# Steinway M Pattern Leading



Let's look at a method for laying out a lead pattern on a new key set...



# Steinway M Pattern Leading

# 37g BW





# Steinway M Pattern Leading



# Steinway M Pattern Leading





# Steinway M Pattern Leading



[illegible]



# LBCC Steinway D Pattern Leading





# LBCC Steinway D Pattern Leading





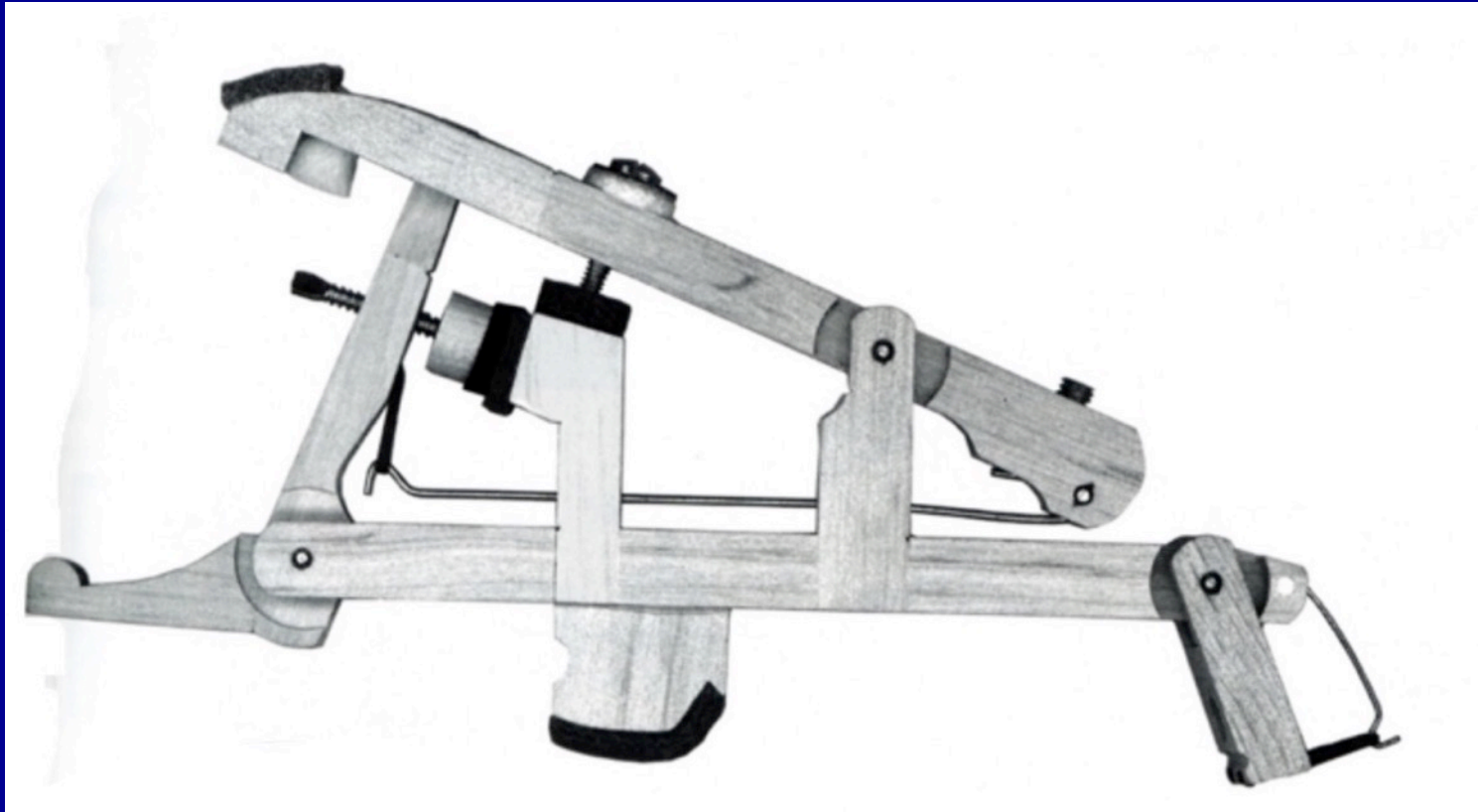
# Note #3 and NO LEAD? Why?





# Reducing Inertia & Balance Weight

## - Wippen Assist Spring -

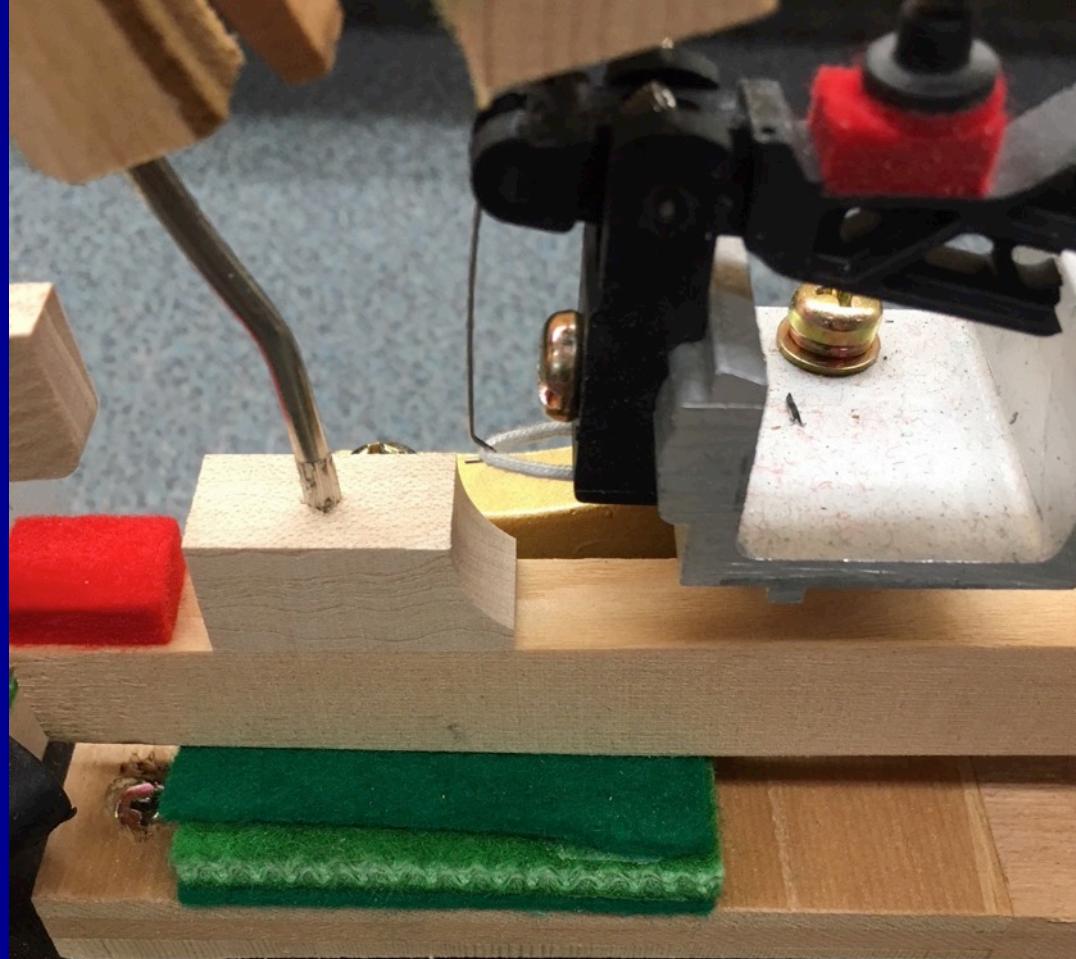


How Strong Should The Spring Be?  
When Do You Adjust Them?









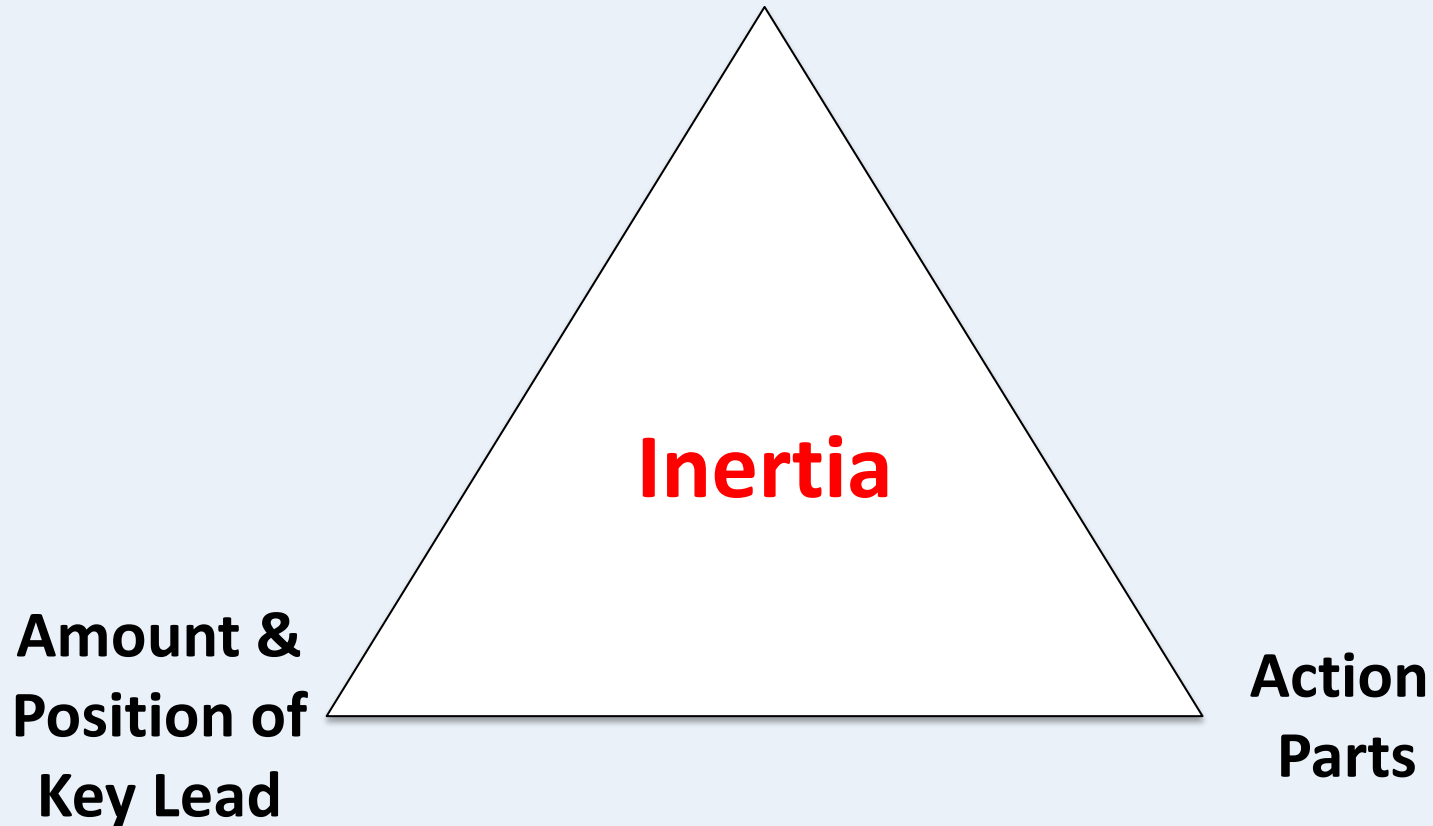
**29g BW  
With  
Spring**



**36g BW  
Without  
Spring**



# What About Hammer Weight



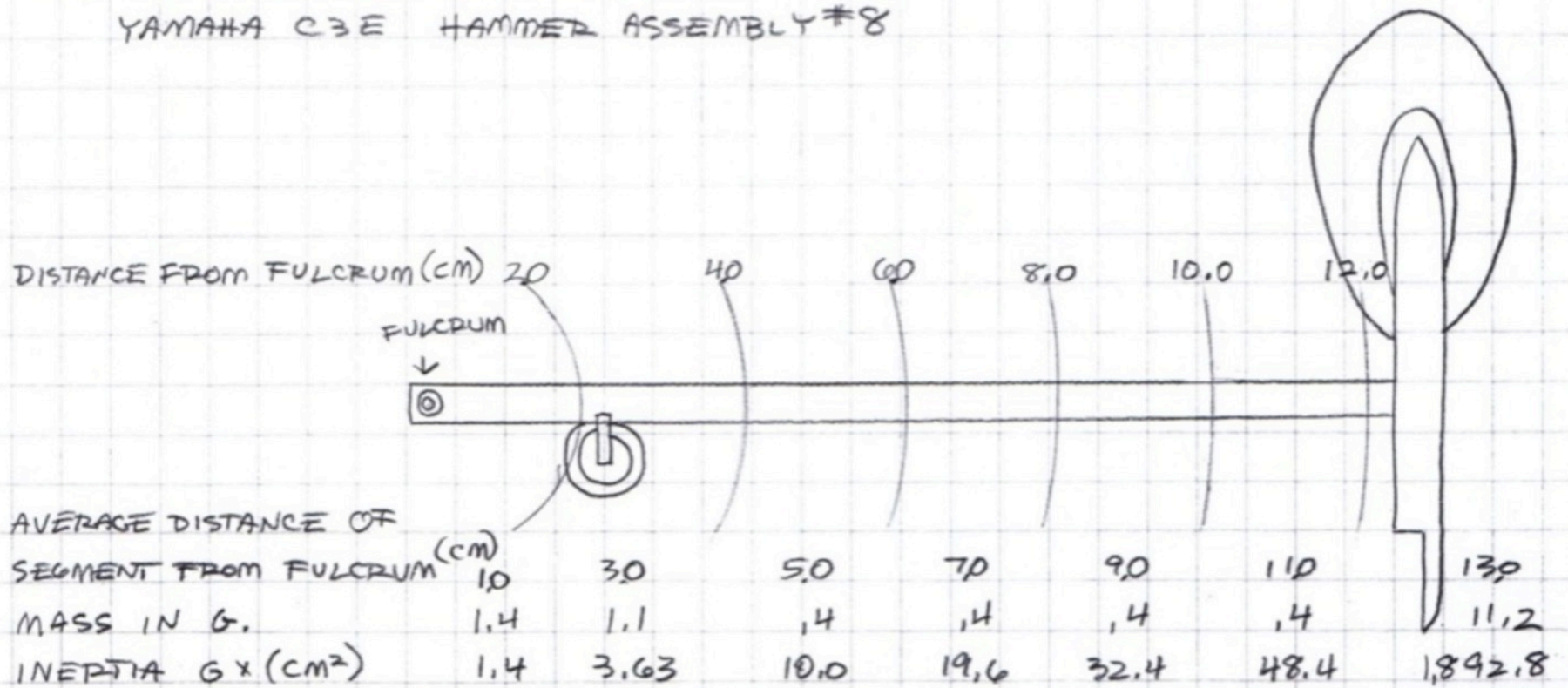
$$\text{Moment of Inertia} = \text{grams} \times \text{cm}^2$$



# Effect of Weight of Shank & Hammer (Strike Weight)

## POLAR MOMENT OF INERTIA STUDY

YAMAHA C3E HAMMER ASSEMBLY #8



TOTAL INERTIA OF ASSEMBLY: 2,008.23



**Weight  
Consideration**

**Hammers  
Weight  
Original vs. New**

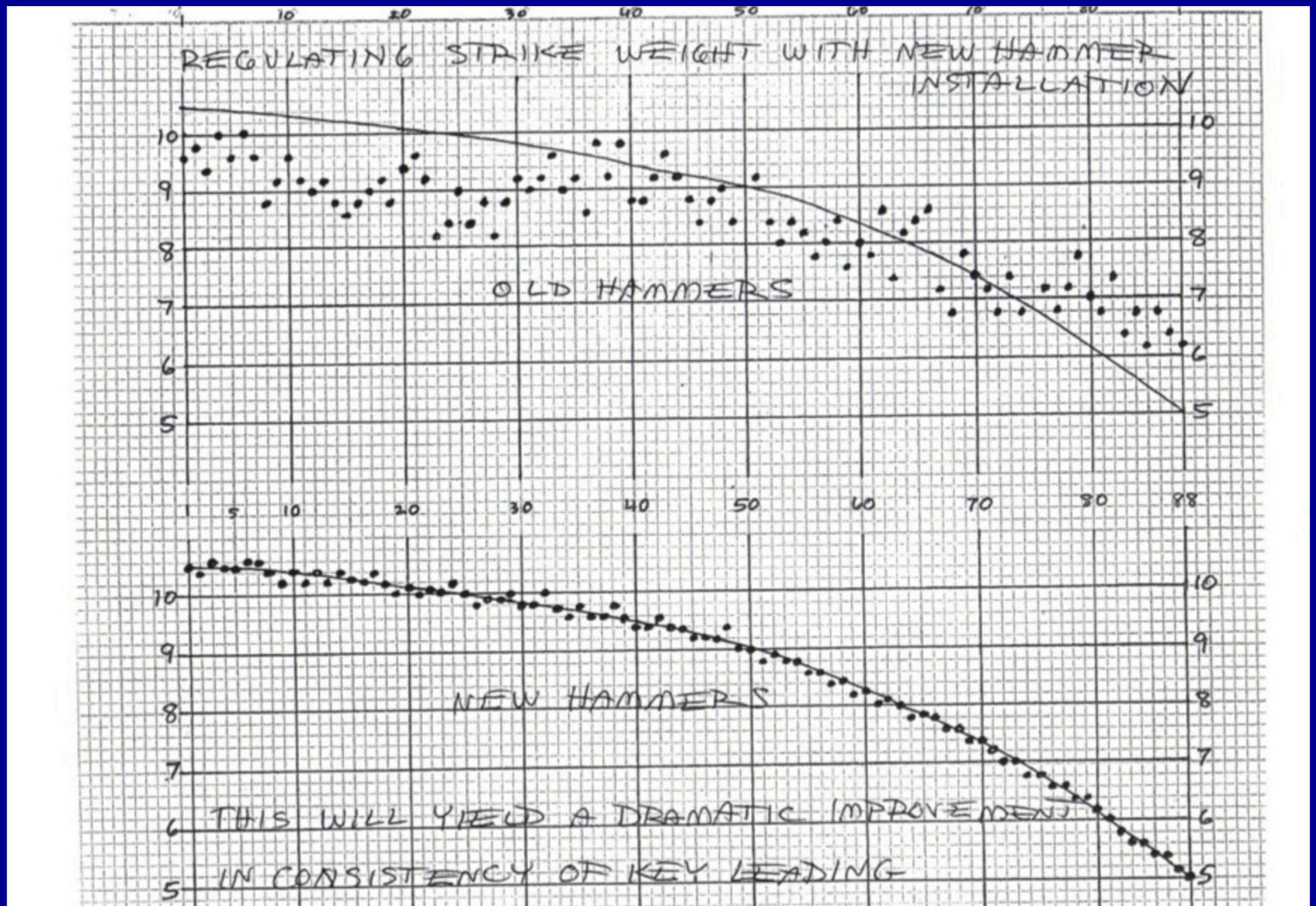
**Proper Bore  
Length & Prep  
[Supplier or Custom]**

**Key Leading  
Changes**



# Hammer Weight Considerations

- How Heavy? Concert vs Home setting? How big of a difference is there? Action Ratio will determine the limitations!
- How consistent is the reduction in hammer weight bass to treble?
- Lead position for a given hammer weight especially in the bass and tenor sections
- New Hammer Weight – Old parts vs New Parts



Proper New Hammer Prep Yields These Results



Piano/Model M4H BB Serial# 34898 Date: 6/14Owner Info: [Name] [REDACTED]Hammer Type: [Original] \_\_\_\_\_ [New Hammer Type] Ronsen

(For Hammer Installation) [O] Original [R] Raw [F] Final [SW] ShankWgt [HW] HammerWgt

(For Balance Weigh-Off) [DW] DownWgt [UW] UpWgt [BW] BalanceWgt

| (For Balance Weigh-Off) |      |     |     |    |      |     |     |    |     |     |     | [DW] Downwgt |     | [DW] Upwgt | [DW] Balance Wgt |  |  |  |  |  |
|-------------------------|------|-----|-----|----|------|-----|-----|----|-----|-----|-----|--------------|-----|------------|------------------|--|--|--|--|--|
| SW                      |      |     |     | SW |      |     |     |    |     |     |     |              |     |            |                  |  |  |  |  |  |
| 1                       | 11.3 | 9.3 | 9.7 | 23 |      | 8.1 |     | 45 |     | 7.1 |     | 67           | 6.7 | 4.9        | 5.1              |  |  |  |  |  |
| 2                       |      | 9.6 |     | 24 |      | 8.1 |     | 46 |     | 6.9 |     | 68           |     | 4.8        |                  |  |  |  |  |  |
| 3                       |      | 9.6 |     | 25 | 10.0 | 8.1 | 8.3 | 47 |     | 6.9 |     | 69           |     | 4.8        |                  |  |  |  |  |  |
| 4                       |      | 9.5 |     | 26 |      | 8.0 |     | 48 |     | 6.8 |     | 70           |     | 4.6        |                  |  |  |  |  |  |
| 5                       |      | 9.2 |     | 27 |      | 8.1 |     | 49 | 8.1 | 6.7 | 6.9 | 71           |     | 4.5        |                  |  |  |  |  |  |
| 6                       |      | 9.1 |     | 28 |      | 8.0 |     | 50 |     | 6.7 |     | 72           |     | 4.4        |                  |  |  |  |  |  |
| 7                       | 10.3 | 9.1 | 9.3 | 29 |      | 8.0 |     | 51 |     | 6.8 |     | 73           | 5.6 | 4.4        | 4.6              |  |  |  |  |  |
| 8                       |      | 9.0 |     | 30 |      | 8.1 |     | 52 |     | 6.8 |     | 74           |     | 4.5        |                  |  |  |  |  |  |
| 9                       |      | 9.1 |     | 31 | 9.2  | 8.0 | 8.3 | 53 |     | 6.9 |     | 75           |     | 4.5        |                  |  |  |  |  |  |
| 10                      |      | 9.1 |     | 32 |      | 8.0 |     | 54 |     | 6.8 |     | 76           |     | 4.4        |                  |  |  |  |  |  |
| 11                      |      | 9.0 |     | 33 |      | 7.9 |     | 55 | 6.9 | 6.3 | 6.4 | 77           |     | 4.3        |                  |  |  |  |  |  |
| 12                      |      | 9.1 |     | 34 |      | 7.8 |     | 56 |     | 6.2 |     | 78           |     | 4.3        |                  |  |  |  |  |  |
| 13                      | 10.4 | 9.0 | 9.2 | 35 |      | 7.7 |     | 57 |     | 6.2 |     | 79           | 4.8 | 4.2        | 4.4              |  |  |  |  |  |
| 14                      |      | 9.0 |     | 36 |      | 7.6 |     | 58 |     | 6.0 |     | 80           |     | 4.2        |                  |  |  |  |  |  |
| 15                      |      | 8.9 |     | 37 | 9.0  | 7.4 | 7.5 | 59 |     | 5.8 |     | 81           |     | 4.2        |                  |  |  |  |  |  |
| 16                      |      | 8.9 |     | 38 |      | 7.3 |     | 60 |     | 6.0 |     | 82           |     | 4.2        |                  |  |  |  |  |  |
| 17                      |      | 8.9 |     | 39 |      | 7.5 |     | 61 | 6.9 | 5.9 | 6.1 | 83           |     | 4.2        |                  |  |  |  |  |  |
| 18                      |      | 8.9 |     | 40 |      | 7.5 |     | 62 |     | 5.5 |     | 84           |     | 4.1        |                  |  |  |  |  |  |
| 19                      |      | 8.9 |     | 41 |      | 7.5 |     | 63 |     | 5.4 |     | 85           | 3.9 | 4.2        | 4.3              |  |  |  |  |  |
| 20                      |      | 8.9 |     | 42 |      | 7.2 |     | 64 |     | 5.1 |     | 86           |     | 4.2        |                  |  |  |  |  |  |
| 21                      | 10.4 | 8.8 | 8.9 | 43 | 8.8  | 7.2 | 7.3 | 65 |     | 5.1 |     | 87           |     | 3.9        |                  |  |  |  |  |  |
| 22                      |      | 8.2 |     | 44 |      | 7.2 |     | 66 |     | 5.0 |     | 88           |     | 3.7        |                  |  |  |  |  |  |

NOTES:

Piano/Model Steinway M Serial# 206988 Date: 5/10/16

Owner Info: [Name] [REDACTED]

Hammer Type: [Original] \_\_\_\_\_ [New Hammer Type] Steinway

(For Hammer Installation) [O] Original [R] Raw [F] Final [SW] ShankWgt [HW] HammerWgt

(For Balance Weigh-Off) [DW] DownWgt [UW] UpWgt [BW] BalanceWgt

| 1  | 8.6 | 9.2 | 23 | 9.0 | 8.6 | 45 | 7.9 | 67 | 6.0 |
|----|-----|-----|----|-----|-----|----|-----|----|-----|
| 2  | 8.7 | 9.1 | 24 | 9.0 | 8.5 | 46 | 7.9 | 68 | 6.1 |
| 3  | 8.5 | 9.1 | 25 | 8.9 | 8.5 | 47 | 7.9 | 69 | 6.0 |
| 4  | 8.6 | 9.1 | 26 | 8.8 | 8.5 | 48 | 7.9 | 70 | 6.0 |
| 5  | 8.5 | 9.0 | 27 | 8.1 |     | 49 | 7.6 | 71 | 5.7 |
| 6  | 8.7 | 8.9 | 28 | 8.1 |     | 50 | 7.6 | 72 | 5.6 |
| 7  | 8.8 | 8.9 | 29 | 8.1 |     | 51 | 7.5 | 73 | 5.4 |
| 8  | 8.7 | 8.9 | 30 | 8.2 |     | 52 | 7.5 | 74 | 5.5 |
| 9  | 8.6 | 8.9 | 31 | 8.3 |     | 53 | 7.3 | 75 | 5.4 |
| 10 | 8.8 | 8.9 | 32 | 8.1 |     | 54 | 7.4 | 76 | 5.4 |
| 11 | 8.8 | 8.8 | 33 | 8.3 |     | 55 | 7.3 | 77 | 5.5 |
| 12 | 8.8 | 8.8 | 34 | 8.1 |     | 56 | 7.1 | 78 | 5.3 |
| 13 | 8.8 | 8.8 | 35 | 8.1 |     | 57 | 7.1 | 79 | 5.5 |
| 14 | 8.8 | 8.8 | 36 | 8.1 |     | 58 | 7.1 | 80 | 5.4 |
| 15 | 9.1 | 8.8 | 37 | 8.2 |     | 59 | 6.9 | 81 | 5.3 |
| 16 | 9.1 | 8.8 | 38 | 8.3 |     | 60 | 6.8 | 82 | 5.2 |
| 17 | 8.8 | 8.8 | 39 | 8.1 |     | 61 | 6.6 | 83 | 5.3 |
| 18 | 8.8 | 8.7 | 40 | 8.1 |     | 62 | 6.5 | 84 | 5.0 |
| 19 | 8.8 | 8.7 | 41 | 8.2 |     | 63 | 6.4 | 85 | 4.9 |
| 20 | 9.0 | 8.7 | 42 | 8.0 |     | 64 | 6.4 | 86 | 4.9 |
| 21 | 9.2 | 8.7 | 43 | 8.0 |     | 65 | 6.2 | 87 | 4.9 |
| 22 | 9.1 | 8.6 | 44 | 8.1 |     | 66 | 6.1 | 88 | 4.7 |

NOTES:



[illegible]

So Simple! -  
Thank You Brooks, Ltd.

















# Where To Start!





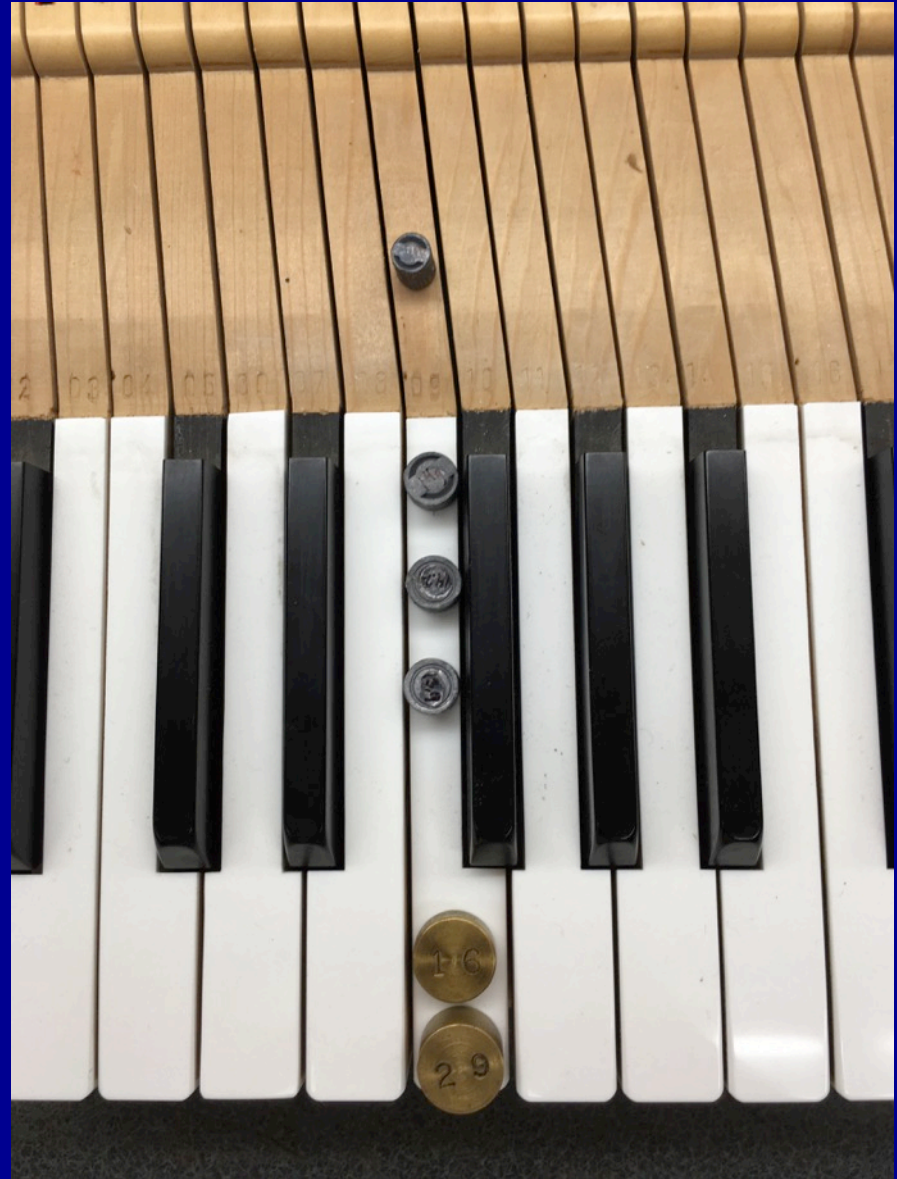


Reasonable  
Hammer  
Weight  
(Note #9)





## Note #9 - 9.6g Hammer Weight



# Juggling Hammer Weight & Key Leading

Know The Lead  
Position Before You  
Prep or Hang A Hammer!



Piano/Model Steinway B Serial# \_\_\_\_\_ Date: 1-8-18

Owner Info: [Name] [REDACTED]

Hammer Type: [Original] \_\_\_\_\_ [New Hammer Type] Steinway

(For Hammer Installation) [O] Original [R] Raw [F] Final [SW] ShankWgt [HW] HammerWgt

(For Balance Weigh-Off) [DW] DownWgt [UW] UpWgt [BW] BalanceWgt

| 1  | 9.2 | 23 | 8.6 | 45 | 7.5 | 67 | 6.2 |  |
|----|-----|----|-----|----|-----|----|-----|--|
| 2  | 9.4 | 24 | 8.6 | 46 | 7.3 | 68 | 6.0 |  |
| 3  | 9.3 | 25 | 8.5 | 47 | 7.3 | 69 | 6.0 |  |
| 4  | 9.3 | 26 | 8.4 | 48 | 7.2 | 70 | 5.8 |  |
| 5  | 9.3 | 27 | 8.2 | 49 | 7.1 | 71 | 5.6 |  |
| 6  | 9.2 | 28 | 8.3 | 50 | 7.3 | 72 | 5.5 |  |
| 7  | 9.3 | 29 | 8.3 | 51 | 7.1 | 73 | 5.5 |  |
| 8  | 9.3 | 30 | 8.3 | 52 | 6.9 | 74 | 5.5 |  |
| 9  | 9.3 | 31 | 8.3 | 53 | 6.9 | 75 | 5.4 |  |
| 10 | 9.3 | 32 | 8.1 | 54 | 6.8 | 76 | 5.4 |  |
| 11 | 9.3 | 33 | 8.1 | 55 | 6.8 | 77 | 5.4 |  |
| 12 | 9.3 | 34 | 8.1 | 56 | 6.8 | 78 | 5.4 |  |
| 13 | 9.3 | 35 | 8.0 | 57 | 6.7 | 79 | 5.3 |  |
| 14 | 9.2 | 36 | 8.0 | 58 | 6.6 | 80 | 5.3 |  |
| 15 | 9.1 | 37 | 8.0 | 59 | 6.5 | 81 | 5.3 |  |
| 16 | 9.1 | 38 | 8.0 | 60 | 6.5 | 82 | 5.3 |  |
| 17 | 9.1 | 39 | 7.8 | 61 | 6.4 | 83 | 5.0 |  |
| 18 | 9.1 | 40 | 7.6 | 62 | 6.4 | 84 | 5.5 |  |
| 19 | 9.0 | 41 | 7.8 | 63 | 6.4 | 85 | 5.4 |  |
| 20 | 9.1 | 42 | 7.5 | 64 | 6.3 | 86 | 5.3 |  |
| 21 | 8.8 | 43 | 7.4 | 65 | 6.3 | 87 | 5.4 |  |
| 22 | 8.7 | 44 | 7.4 | 66 | 6.3 | 88 | 5.3 |  |

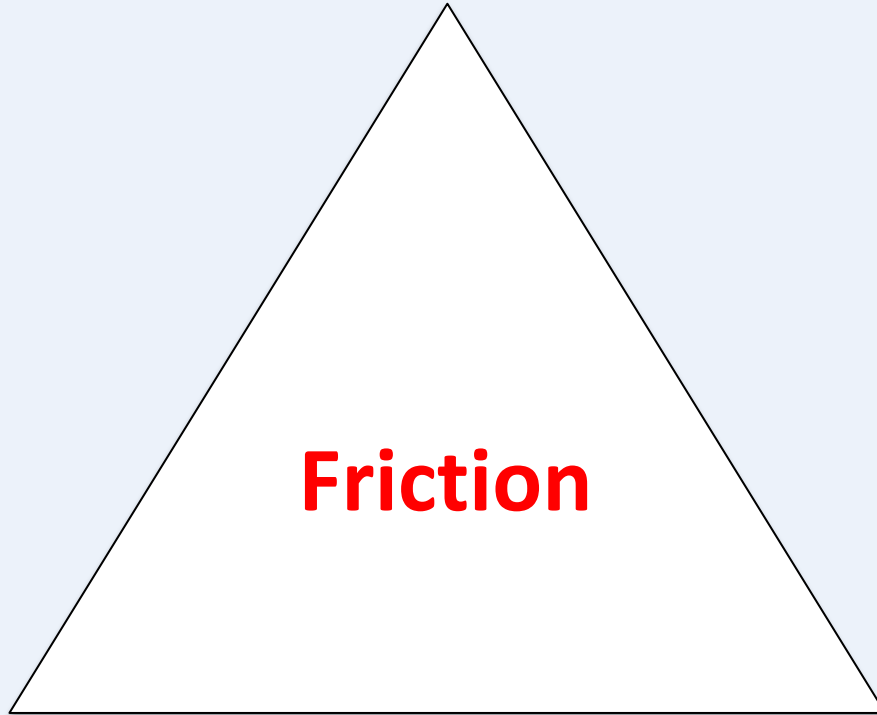
NOTES:

**Action Centers  
& Knuckles**

**Friction**

**Key  
Bushings  
& Pins**

**Capstan/Heel  
 $\frac{1}{2}$  stroke problems**





**Because of hammer weight,  
friction averages 12 - 15 grams  
in the bass tapering to 8 - 10  
grams in the high treble, for  
actions in good condition.**

**A bit less for WN&G Actions**

The most **common causes of excessive friction** *in actions needing service* are **rubbing action parts** between adjacent notes, **knuckles contaminated with oil or grease** (or lacking *proper* knuckle lubrication), **tight key bushings or balance holes**, and **tight action centers**—particularly the hammershank center.

[Bill Spurlock]







# Teflon Might Help!

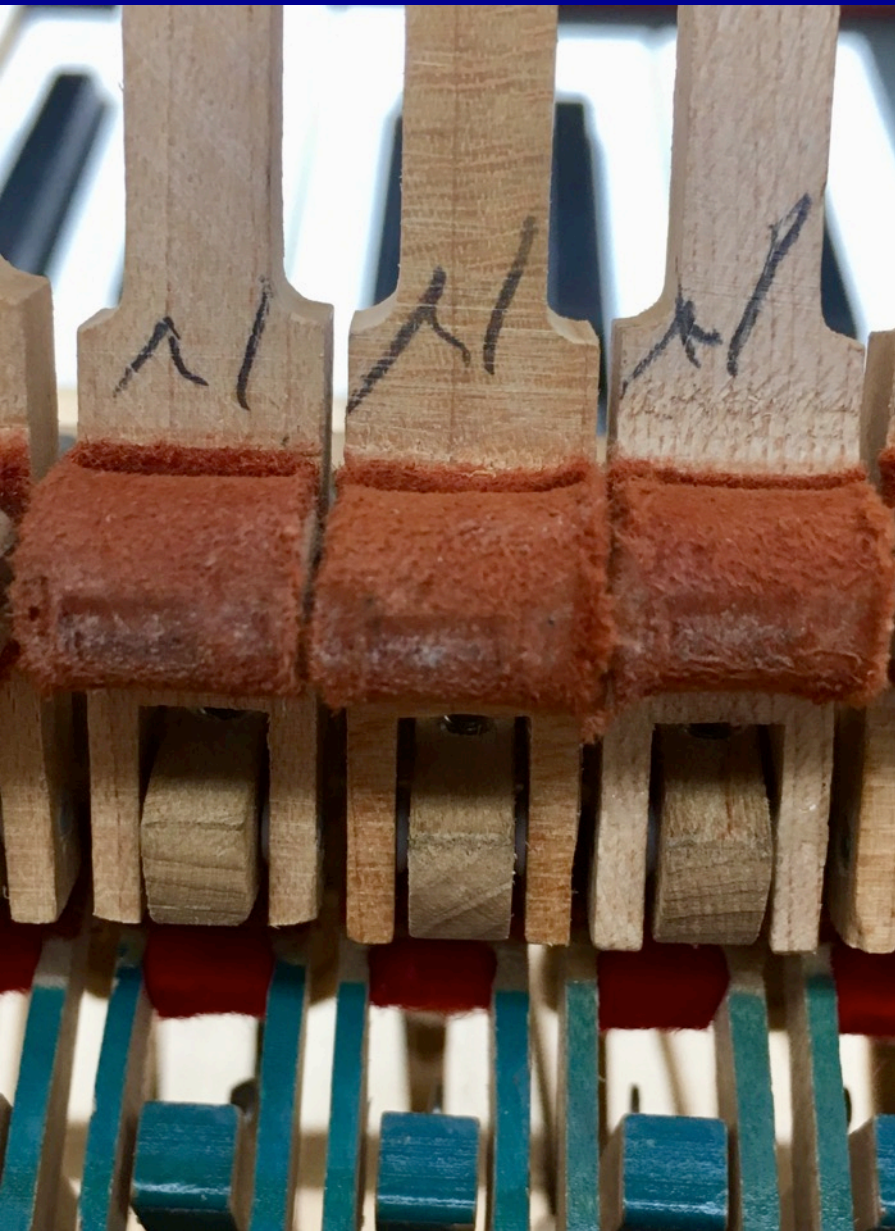
# Watch out for the groove!



**Strange friction could be the result of  
the Knuckle riding on the groove.**



**Accurate Weigh Off Impossible Until Friction Issues Corrected!**









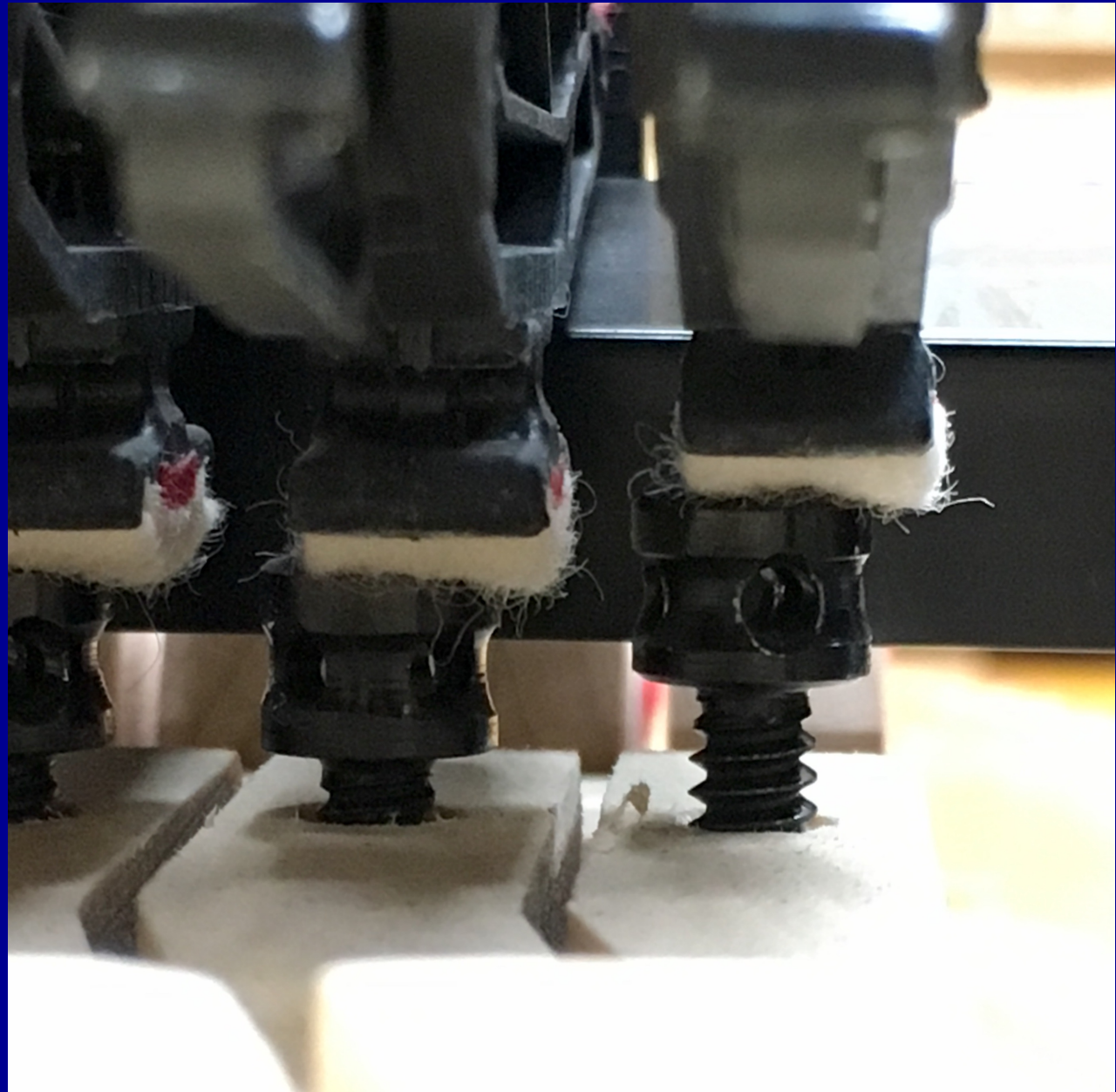
**Flat Knuckles Increase  
Friction &  
Action Ratio**



**Accurate  
Weigh Off Impossible  
If Knuckles Are Flat.**

**Solution  
To  
Mystery  
Friction  
In Action**

**19mm Heel  
- f 16g -  
Change To  
16mm Heel  
- f 13g -**





# Drilling Holes & Working With Lead



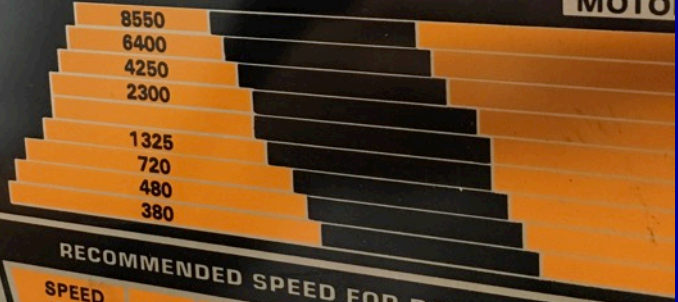
Tapered Bit







# SPINDLE SPEED



## RECOMMENDED SPEED FOR DRILL SIZE AND MATERIAL

| SPEED (RPM) | WOOD  | ZINC DIECAST | ALUM. & BRASS | PLASTIC * | CAST-IRON & BRONZE | STEEL MILD & MALLEABLE |
|-------------|-------|--------------|---------------|-----------|--------------------|------------------------|
| 8550        |       |              |               |           |                    |                        |
| 6400        | 1/8   | 3/32         |               |           |                    |                        |
| 4250        | 1/4   | 3/16         | 5/64          |           |                    |                        |
| 2300        | 3/8   | 1/4          | 5/32          | 1/16      | 3/64               | 1/32                   |
| 1325        | 5/8   | 3/8          | 7/32          | 1/8       | 3/32               | 1/16                   |
| 720         | 1-1/4 | 1/2          | 11/32         | 3/16      | 1/8                | 3/32                   |
| 480         | 1-5/8 | 3/4          | 15/32         | 5/16      | 1/4                | 5/32                   |
| 380         | 2     | 7/8          | 11/16         | 7/16      | 11/32              | 1/4                    |
|             |       | 1            | 3/4           | 5/8       | 1/2                | 3/8                    |
|             |       |              |               | 13/16     |                    | 1/2                    |
|             |       |              |               |           |                    |                        |

\* STYRENE USE RIGHT HAND COLUMN



# Freedom in Drilling Angled Keys





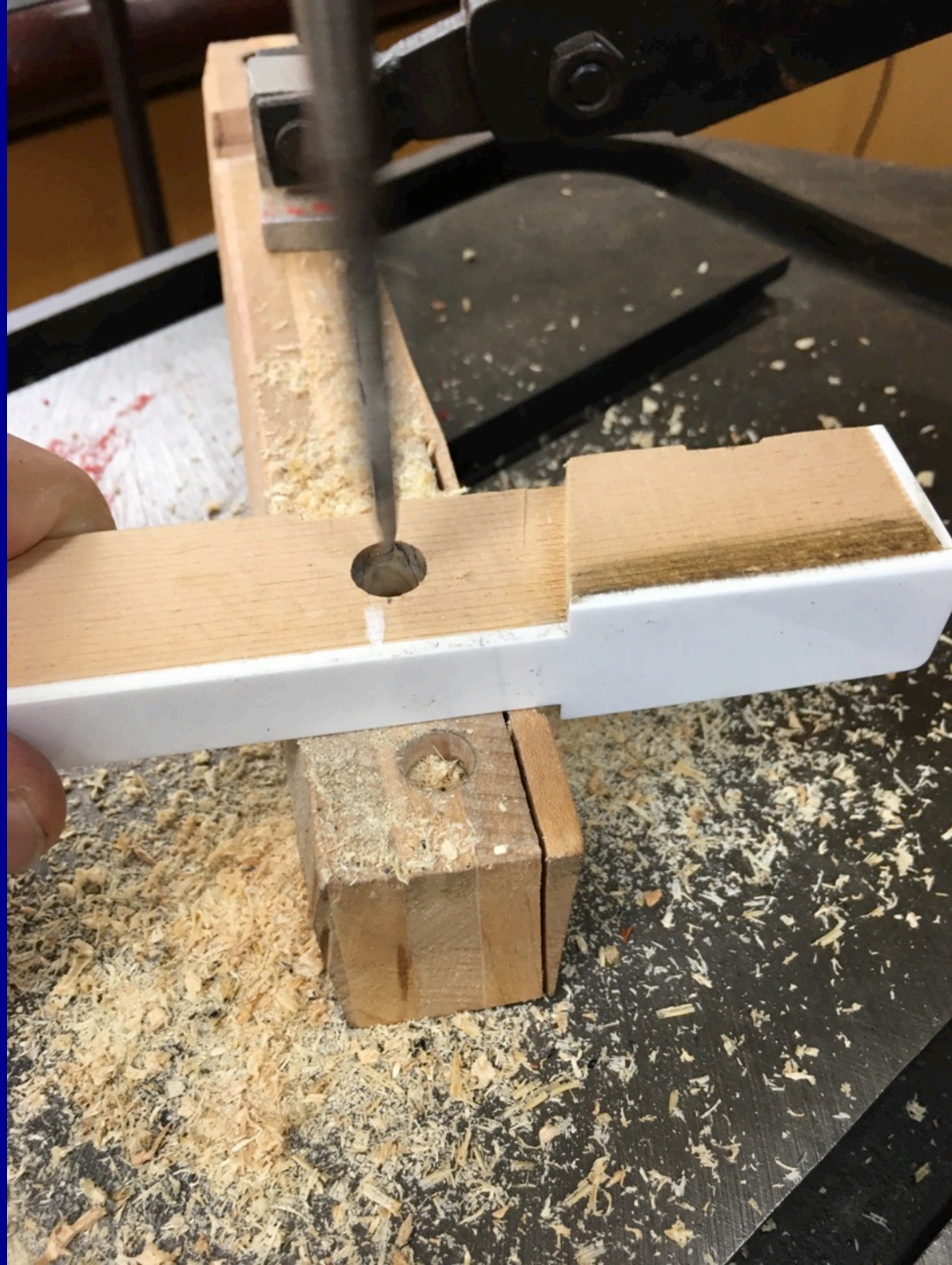




# Enlarge 3/8" Hole To 1/2"









# Gentle Force To Set The Lead





# DeadLeader Pliers – Chris Haberbosch, R.P.T.







**Gentle Tap  
To Expand  
Lead**







# Remove the Whiskers





Create  
A  
Half Lead



Creating a “superior touch weight” is dependent on knowing the relationship between the various action components and how to “regulate” them!

***“If the balance weight is uniform and if the weight of the parts used to build the action are uniform, then inertia will be uniform.”***

**David Stanwood PTGJ 11/1990**