Grand Balancing Act
Act II
Period 2 – Part 1

PTG Annual Convention
Tucson, AZ
2019

Mastering the Art of Superior Touch Weight

“The Big Picture View Before You Begin”

1930 M&H AA Touch Adjuster

Interesting Idea?

Geometry problems? How do you know?

- How do you know when the action is too heavy? Is it a weight issue or voicing issue?
- How do you know when the action is too light? Is the action friction too low?
- How do you know the action is not weighed off properly?
- What is the customer saying (or not saying)?
- It's a fine line between introducing dissatisfaction and offering a solution!

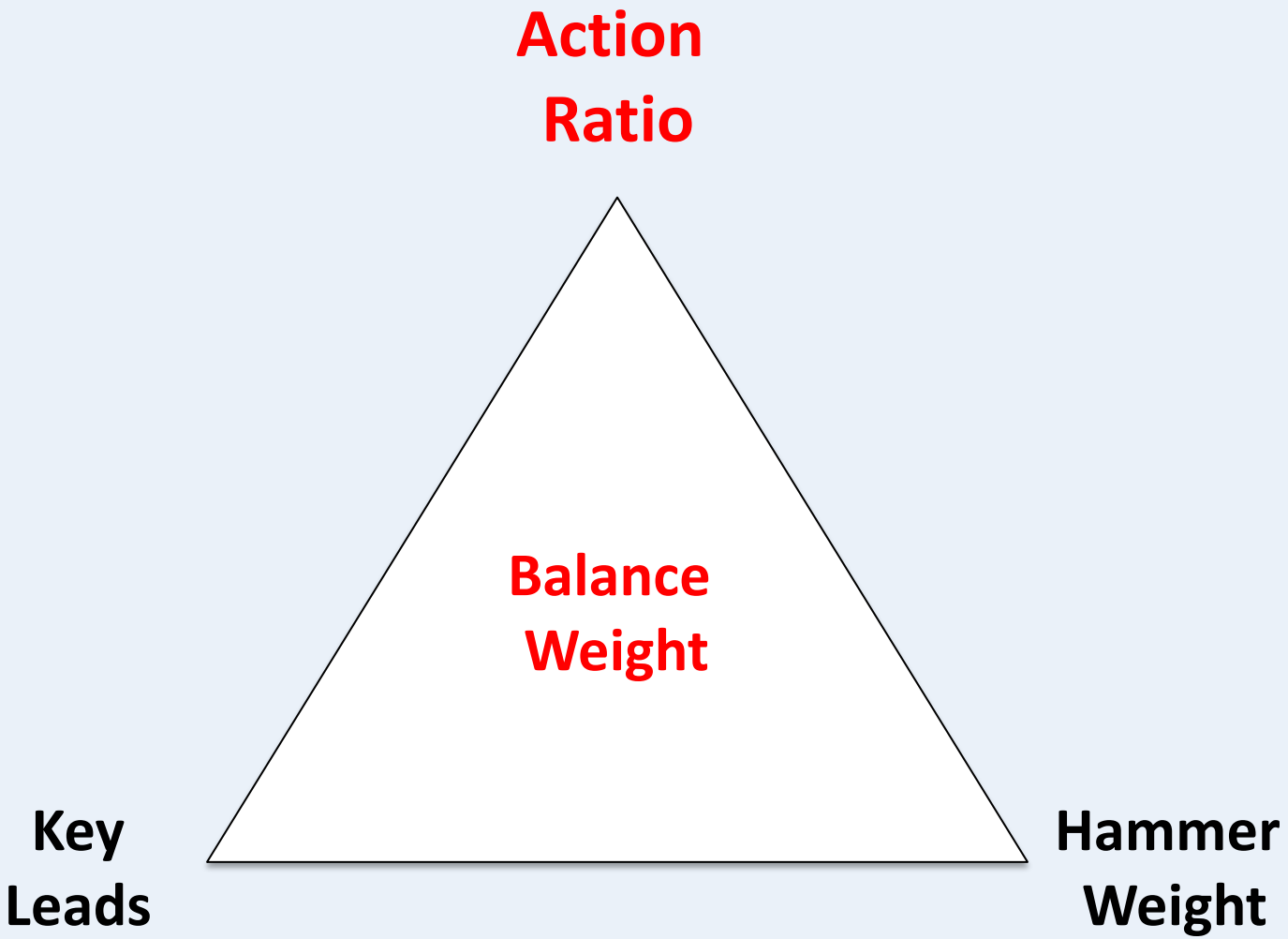
What Do You Need To Know To Answer These and Other Questions?

- Develop Your Observational Skills
- How To Measure and Change Action Ratio
- Action Inertia – Good or Bad?
- Excessive Key Leading and what to do about it
- Requirements for New Hammer Installation
- Selecting the Correct Action Parts
- Correcting Friction Problems
- Understanding the Relationship Between Tone & Touch

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

What Affects the Balance Weight?

1) Changes in Hammer Weight
2) Changes in Lead Weight in keys
3) Change In Action Ratio, i.e. Change in knuckle position; Change in capstan position; Change in balance point of key.
4) Changes in: Knuckle shape (wear), Capstan Weight, Weight of action parts; Adding or adjusting Wippen Assist Springs

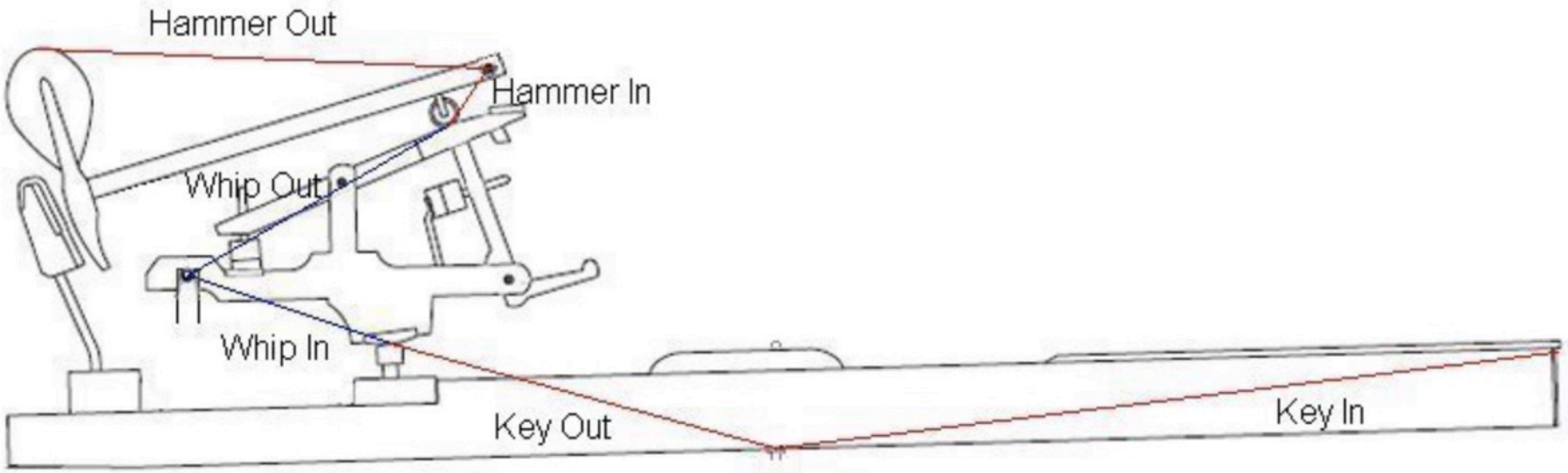


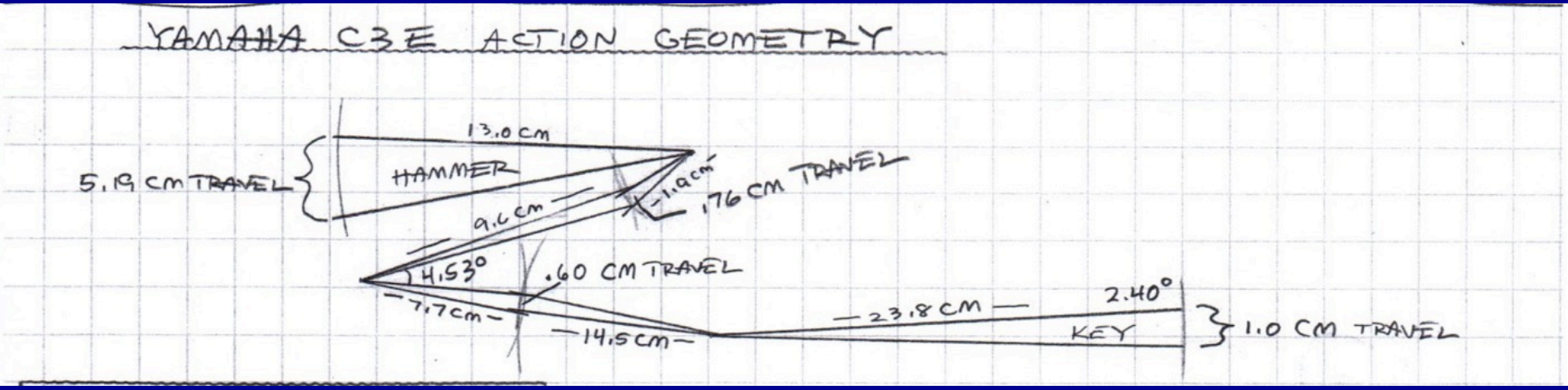
Desired Action Ratio Should Be Determined First!

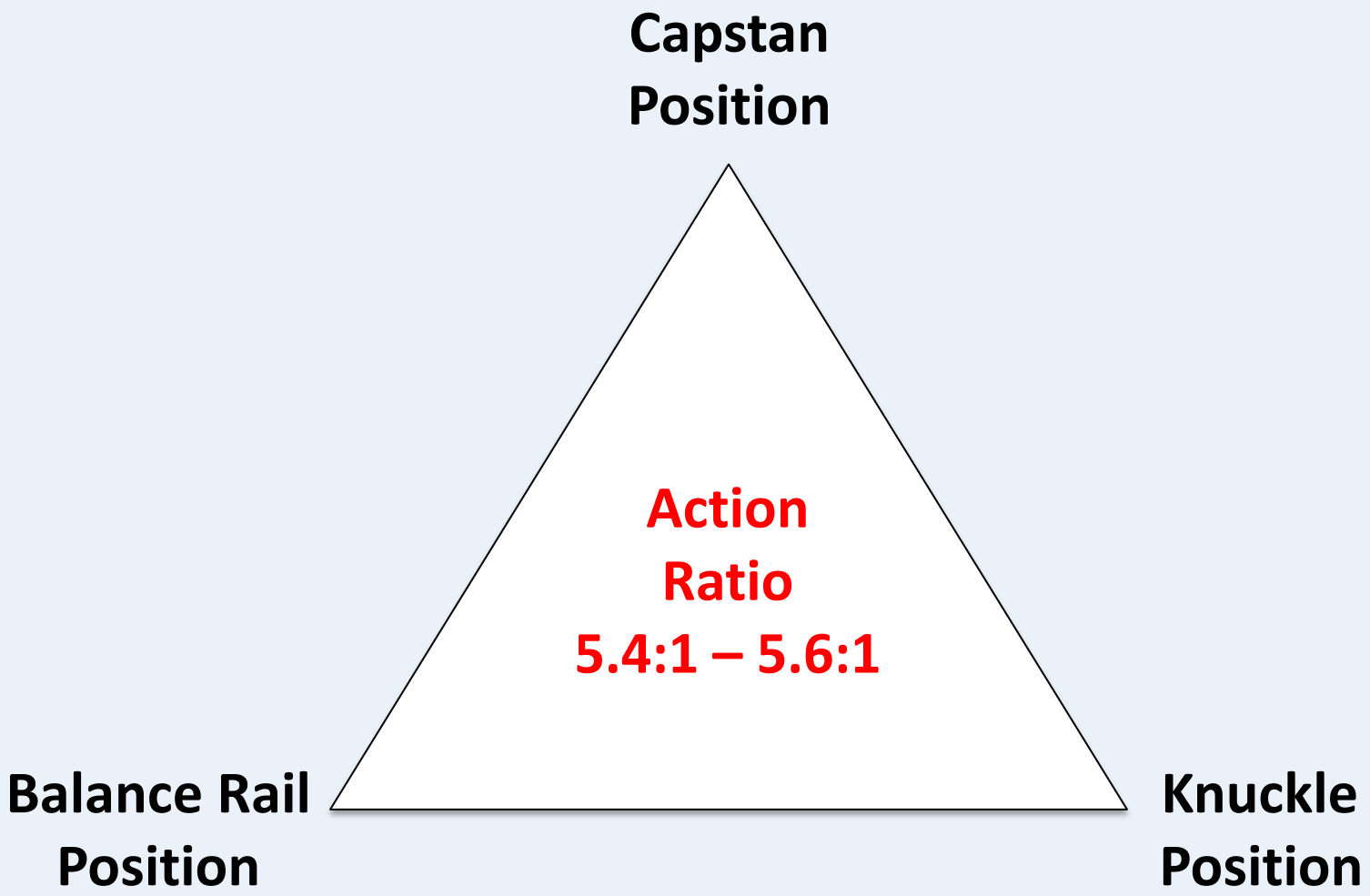
Measuring Action Ratio

Action Ratio is the ratio of hammer travel to key travel. This is a quick and convenient measure of an action's tendency toward inertia and weight problems, and a predictor of what regulation measurements will be necessary for a given action.

[Bill Spurlock]


Hammer Out
Hammer In
Whip Out
Whip In
Key Out
Key In


YAMAHA C3E ACTION GEOMETRY
13.0 cm
5.19 cm TRAVEL
HAMMER
1.9cm
.176 CM TRAVEL
9.6 cm
4.53°
.60 CM TRAVEL
7.7cm
14.5cm
23.8 CM
2.40°
KEY
1.0 CM TRAVEL



For touch weight issues, measuring Action Ratio
1st Most Important Measurement

Measuring Action Ratio

Higher ratio actions will require more key leads and lighter hammers to keep downweight low. They will also regulate with less key dip and longer hammer travel, since the higher ratio gives more hammer travel per unit of key dip.

[Bill Spurlock]

Measuring Action Ratio

"Lower ratio actions will require fewer key leads and can tolerate heavier hammers without creating downweight problems. But, they must be regulated with more key dip and less hammer travel to achieve adequate after touch"

[Bill Spurlock]

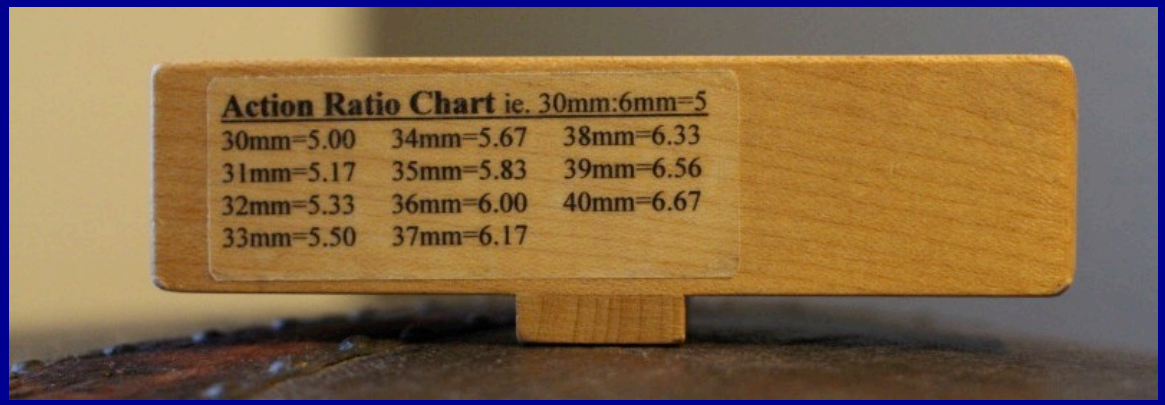
Measuring Action Ratio

(“point of reference”)

Depress Key 5mm

Spurlock Ratio Tester (6mm)

[Available at Erwins Pianos]

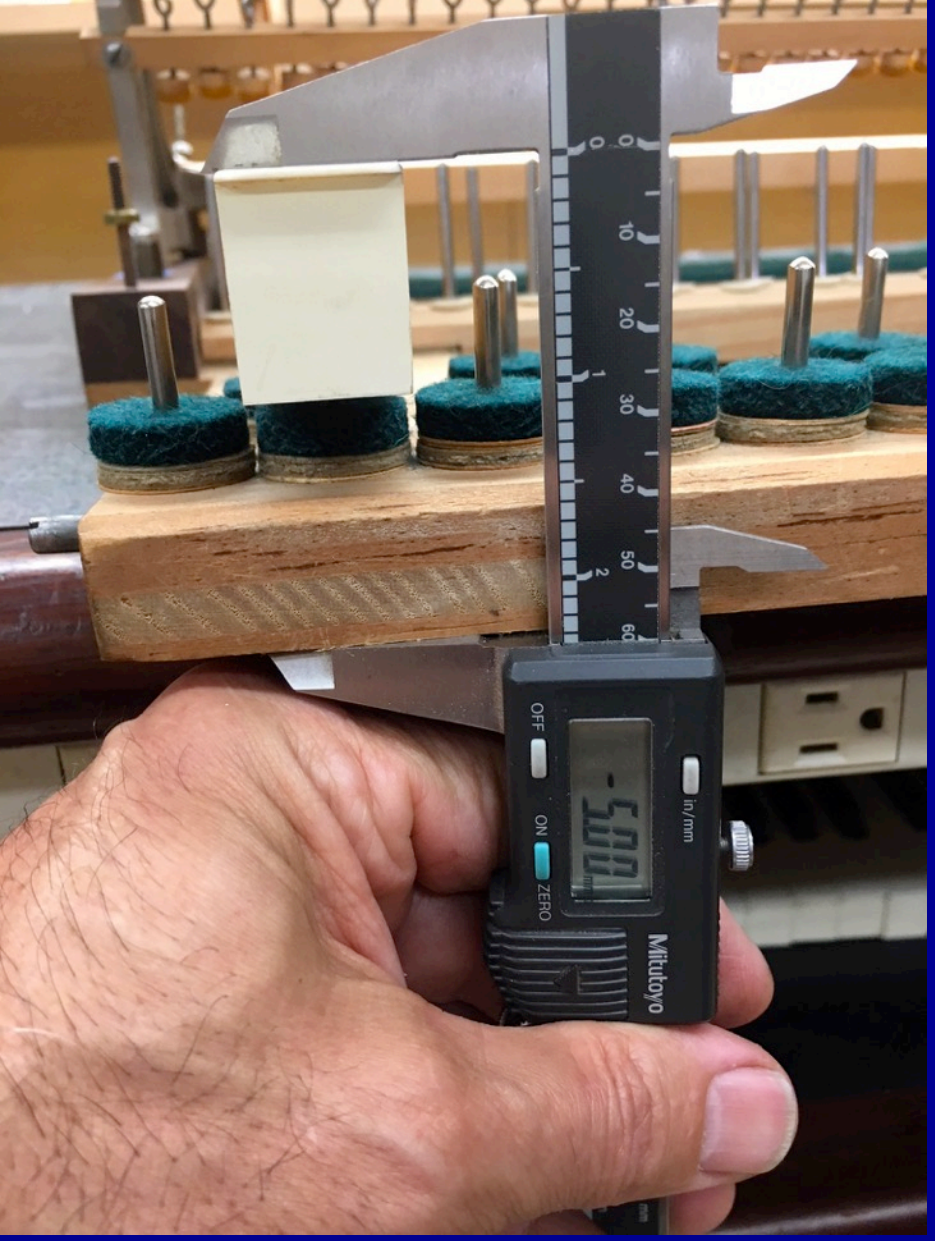


Ratios measured with these methods typically range from 5 to 6+

5mm Key Depression

Action Ratio
32mm ÷ 5mm = 6.4

Another Way to Measure Ratio

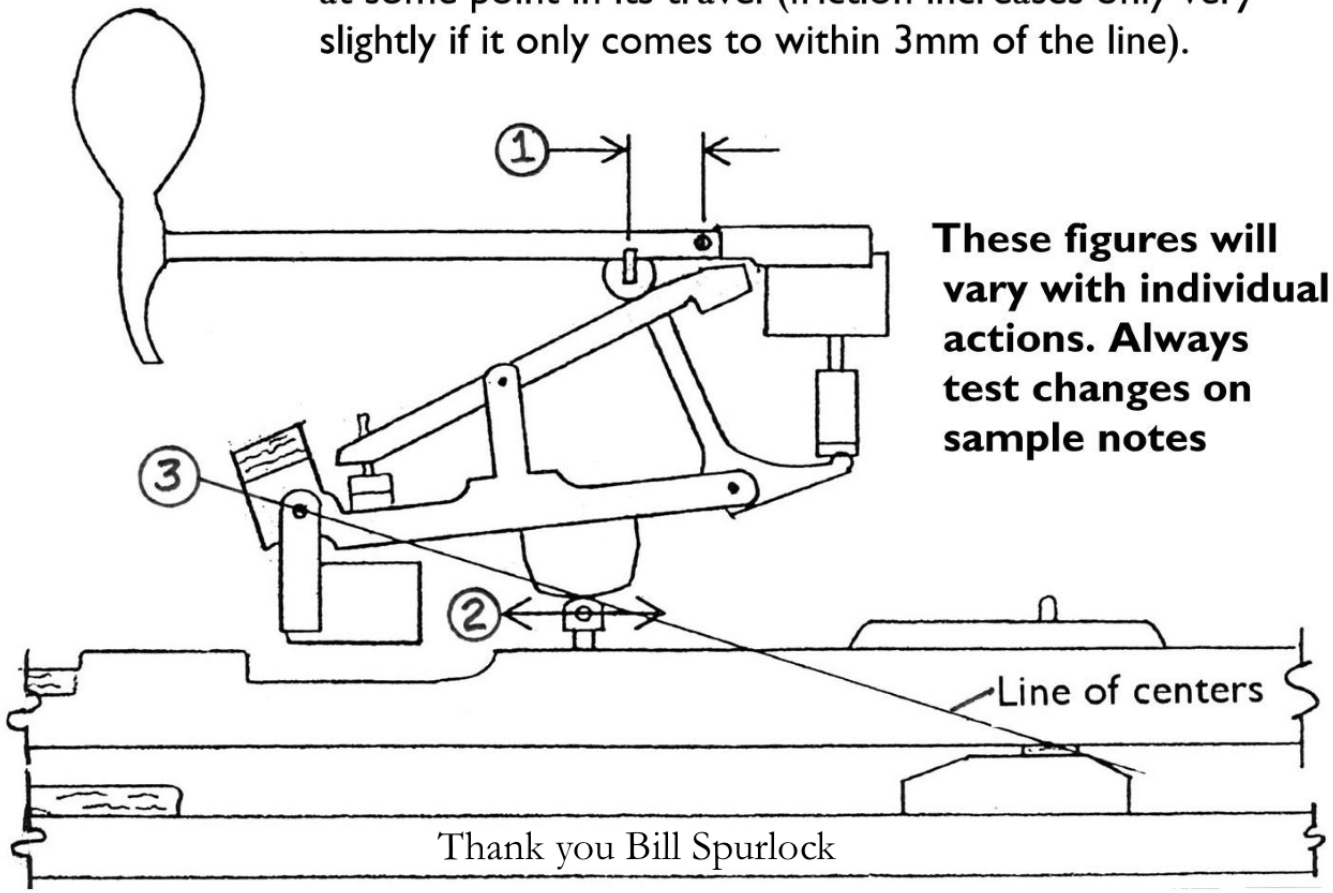


5mm Key Depression

1. Changing to shanks with a 1mm greater knuckle-to-centerpin dimension will lower R by approx. .4 and lower D by about 5gm (vice versa for a 1mm reduction in knuckle/c.p. distance.

2. Moving capstans 2mm toward balance rail will decrease R by approx. .4 and decrease D by approx 5gm (vise versa for moving capstan 2mm back).

3. Ideally the capstan top should meet the line of centers at some point in its travel (friction increases only very slightly if it only comes to within 3mm of the line).



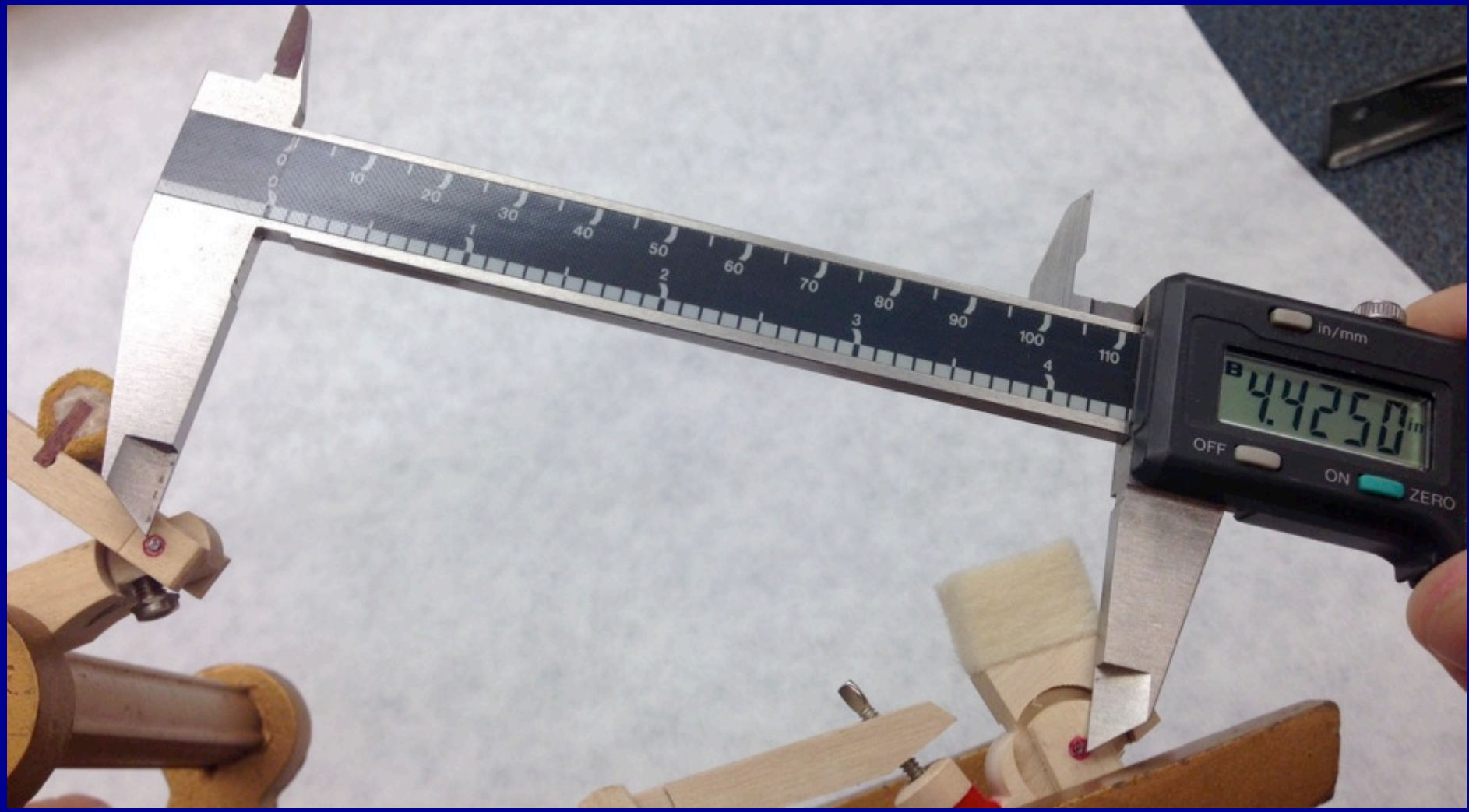
These figures will vary with individual actions. Always test changes on sample notes

Thank you Bill Spurlock

Steinway 15.5mm vs 17mm

1mm Knuckle Change = Approximately .4 Change in Ratio

Action Spread: 111-114mm or 4.425?



Correct
Action Spread
=
Correct
Jack Alignment
With Knuckle

Jack Must Have Room In The Window At The End Of Key Travel (Aftertouch)

1. Changing to shanks with a 1mm greater knuckle-to-centerpin dimension will lower R by approx. .4 and lower D by about 5gm (vice versa for a 1mm reduction in knuckle/c.p. distance.

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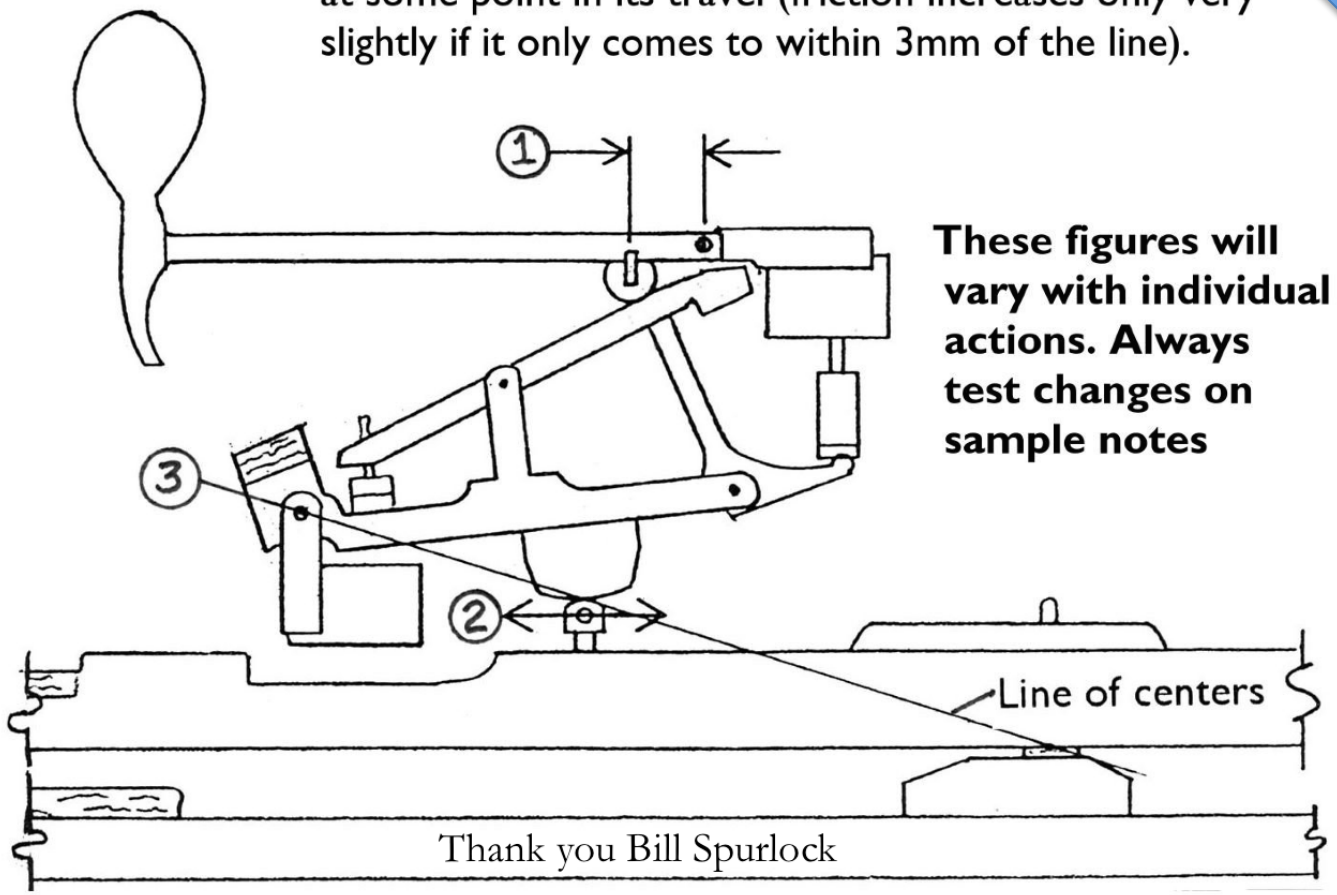

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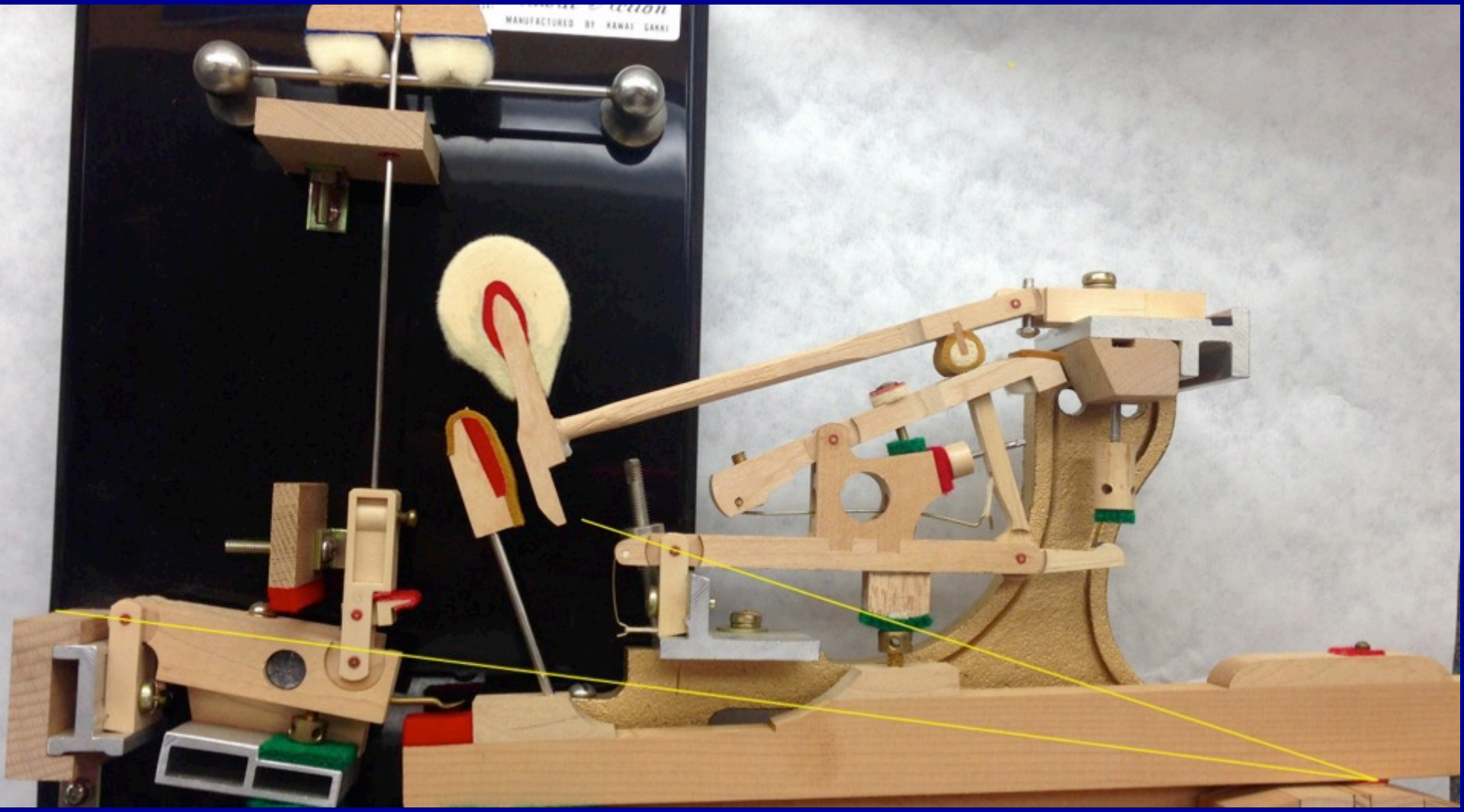
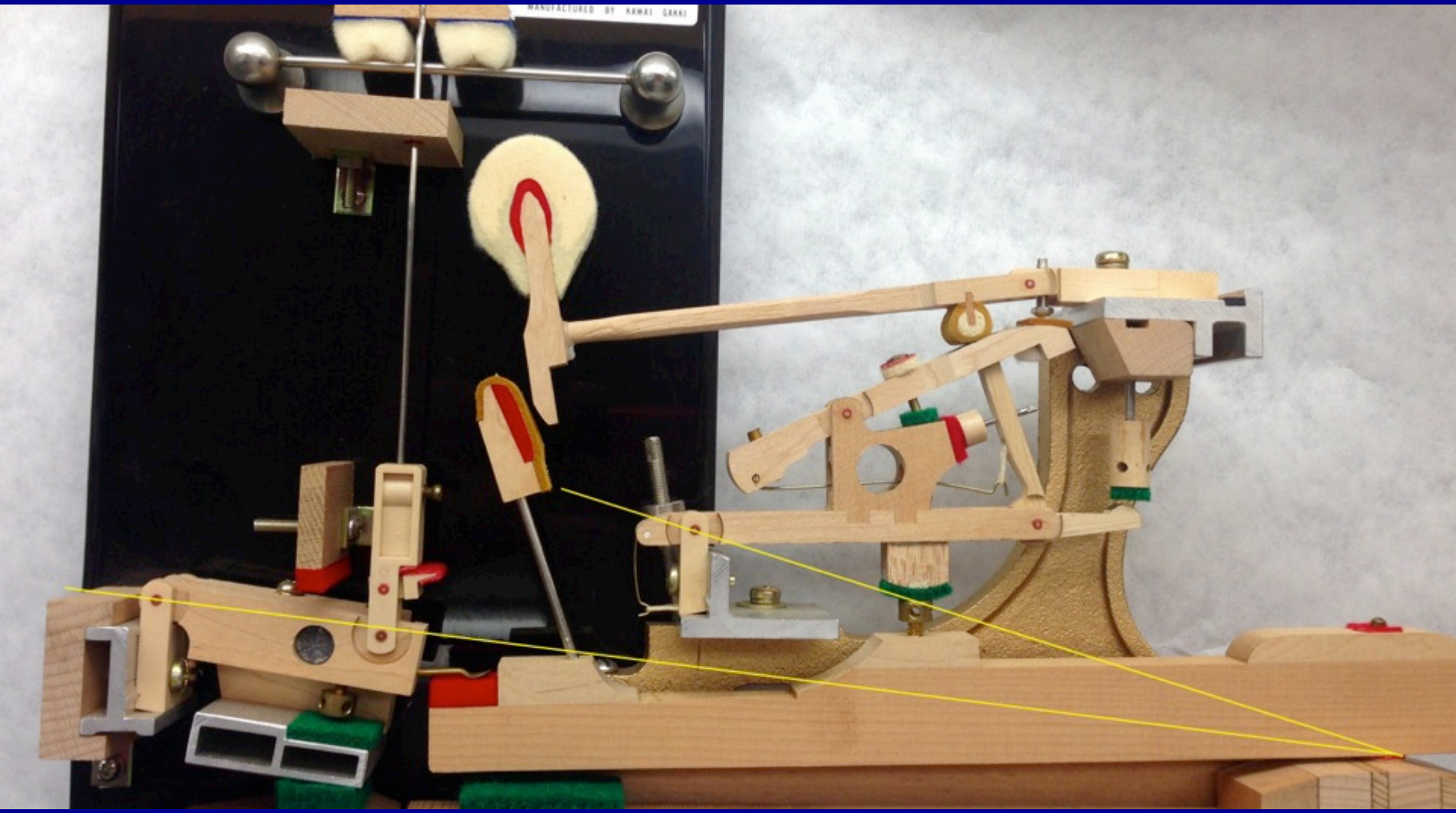
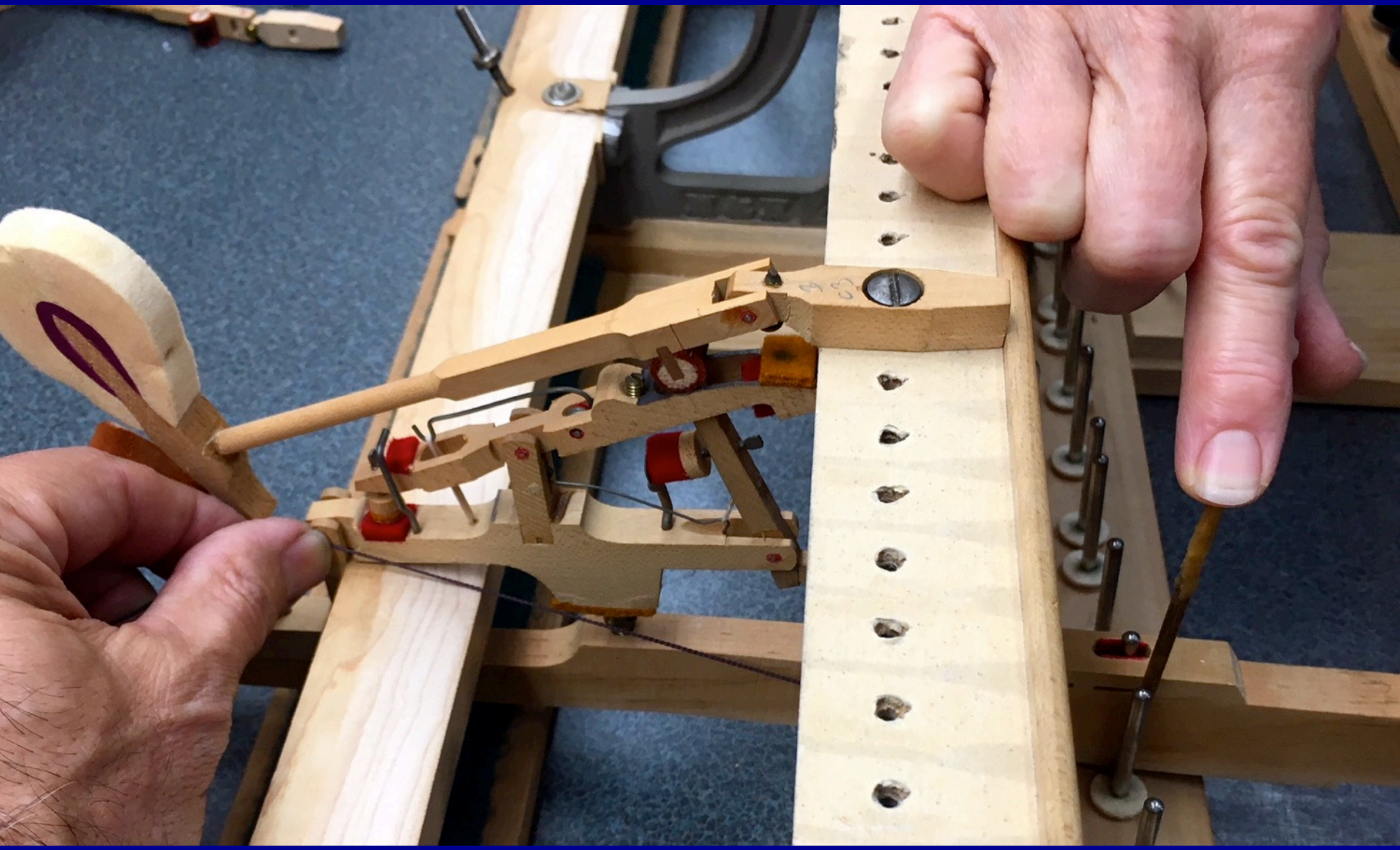
Lines Of Compliance

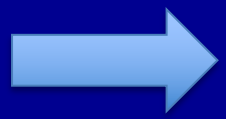


Half Key Travel

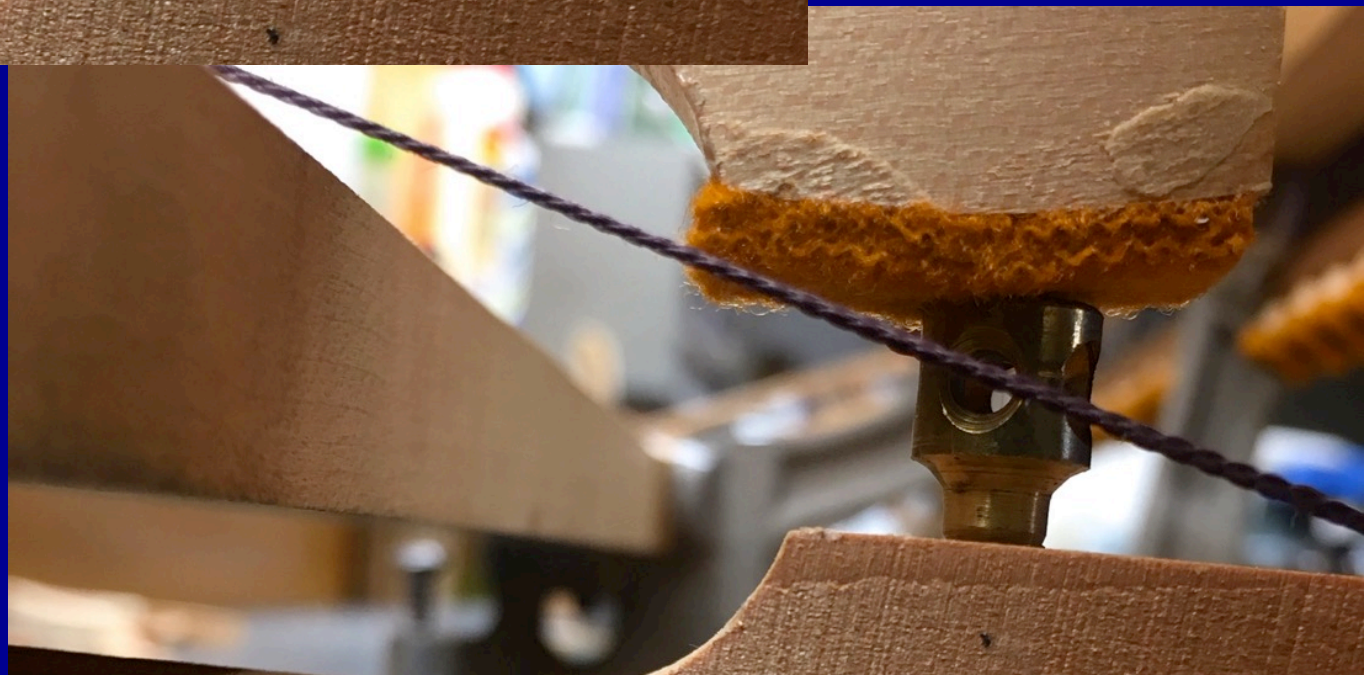




Key At Rest



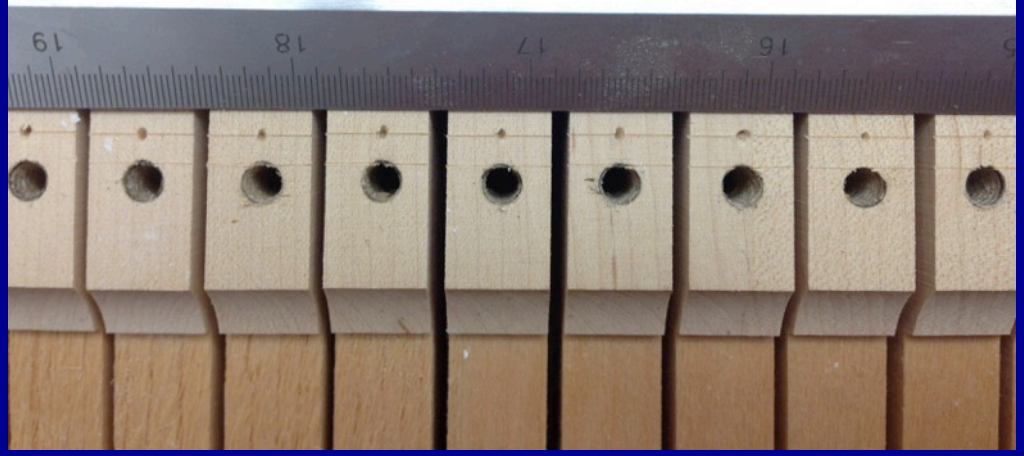
Key Fully Depressed

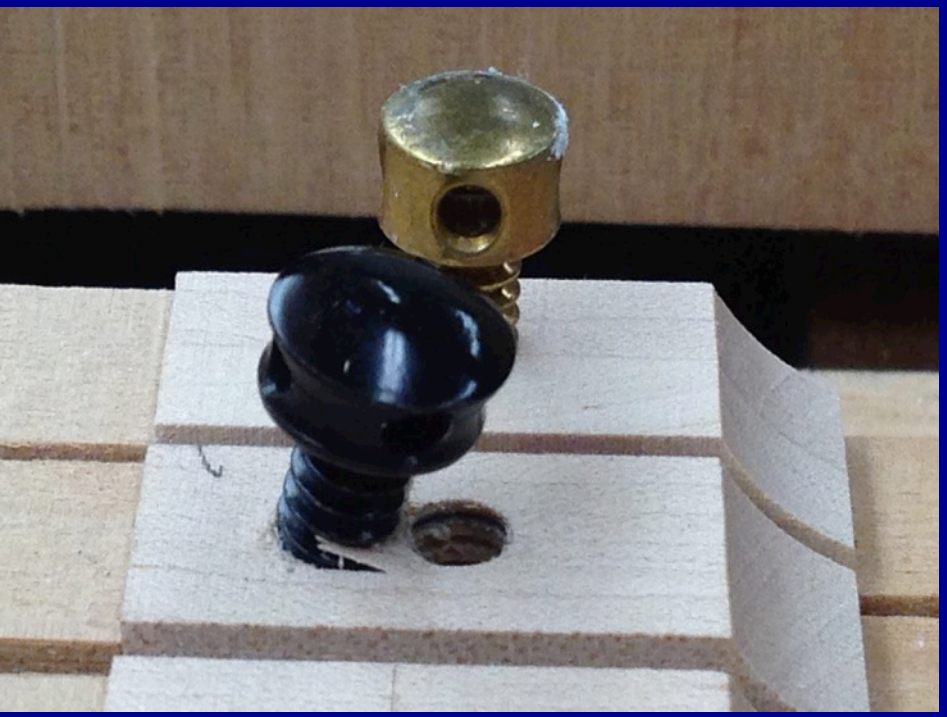


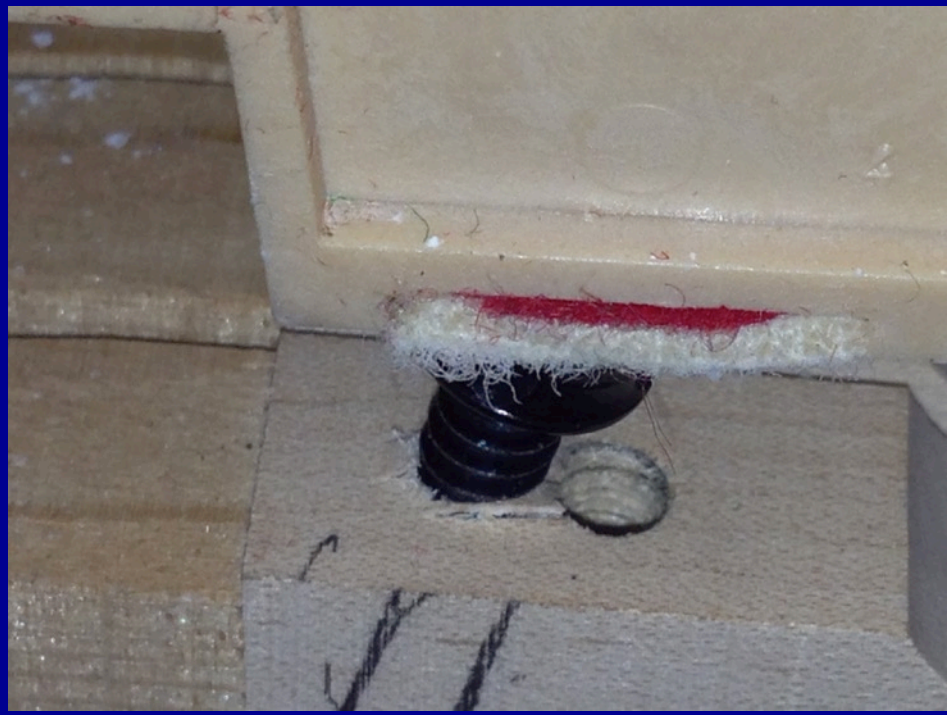
Something's Wrong!

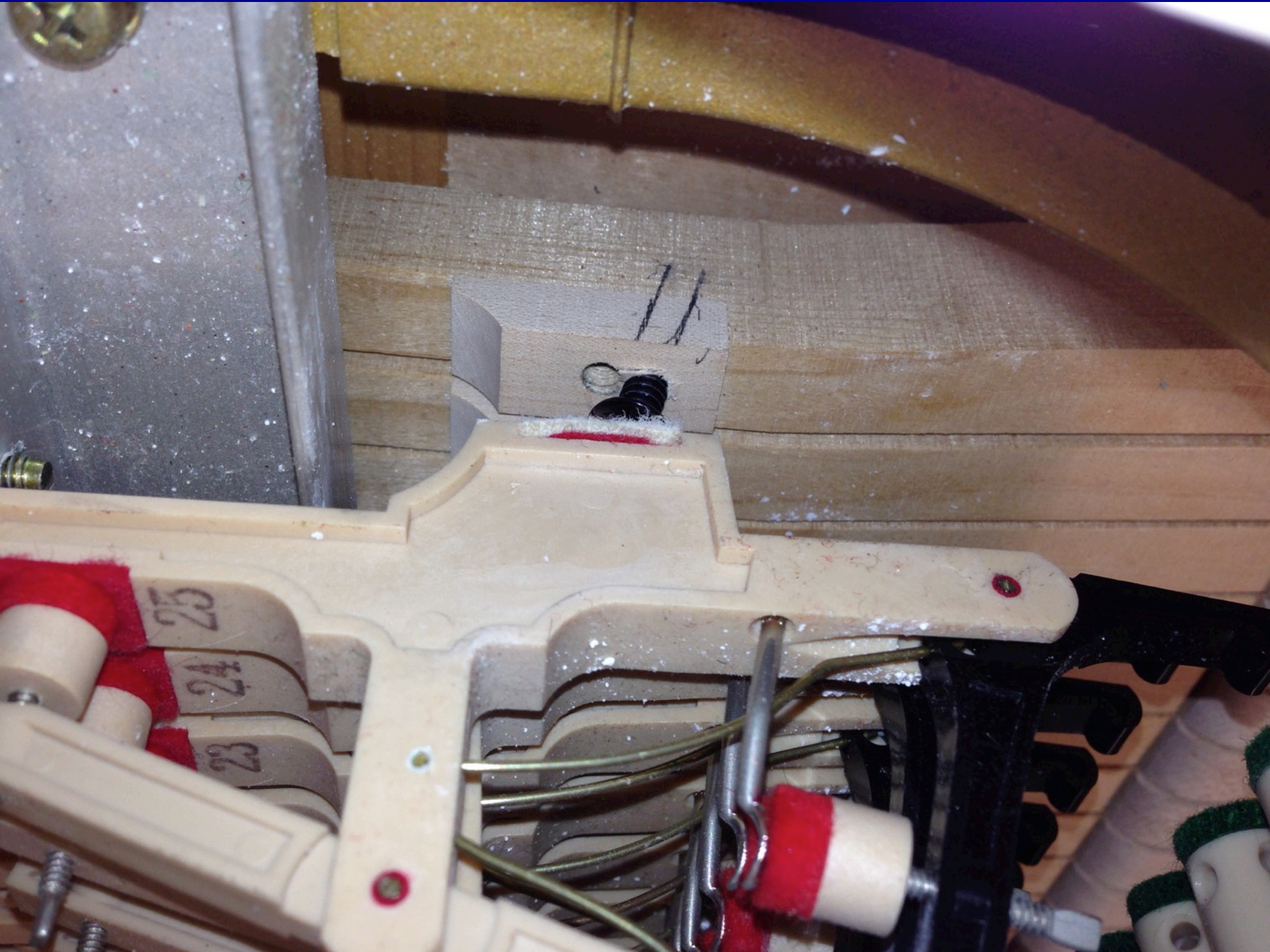
Very Heavy Action!

A Way to Correct
Action Ratio Problems





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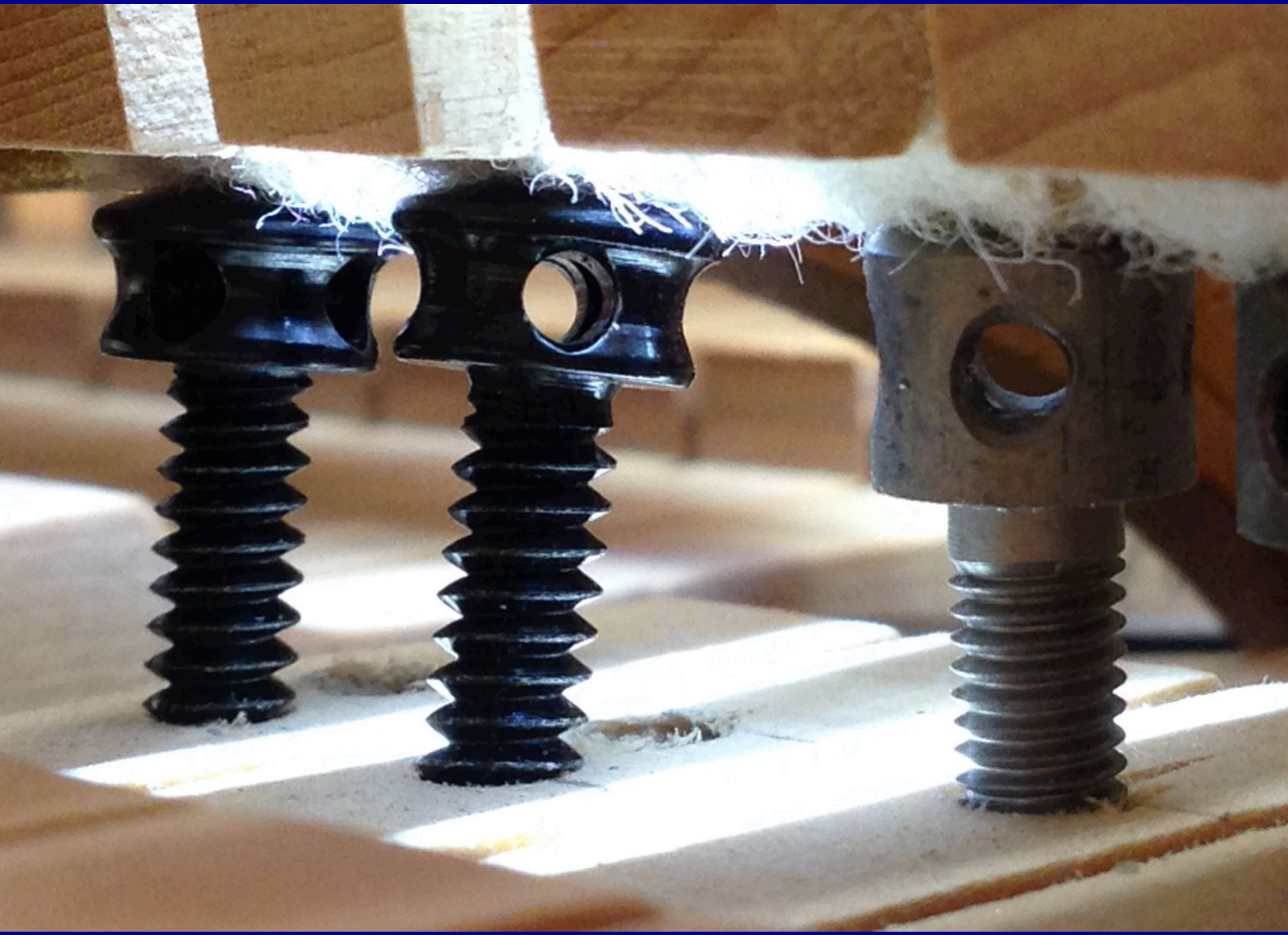
24
23

Quality Straight Edge From Floor Covering Supplies



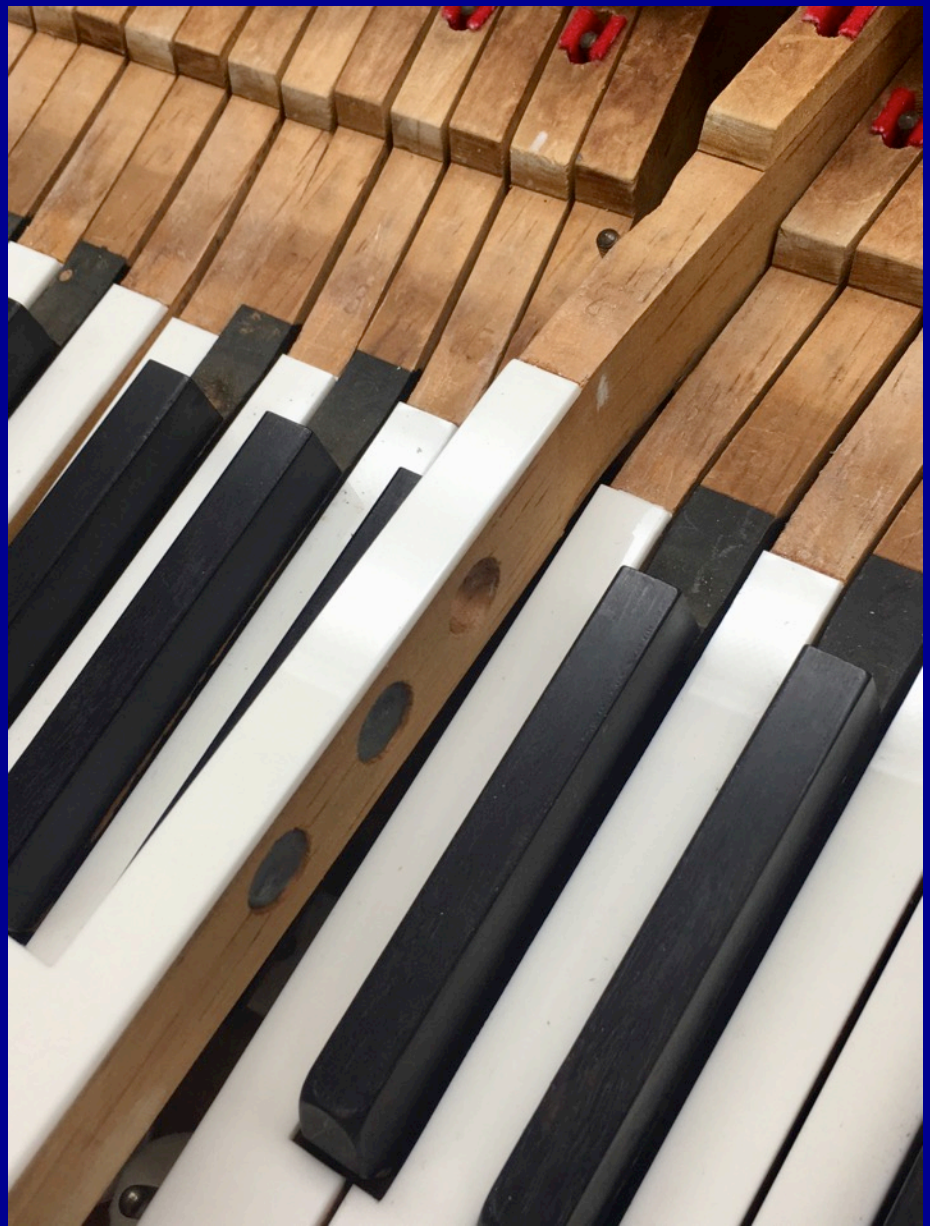
“Were you wondering why the ratio kept changing note to note?”

Change Action Ratio
Modify Balance Punching

Original Ratio 6:1

Cut Punching Ratio 5.6:1

Cut Punching Ratio – 5.8:1



Correct Action Ratio Problems with A Change At The Balance Rail

New Key Set Advantage

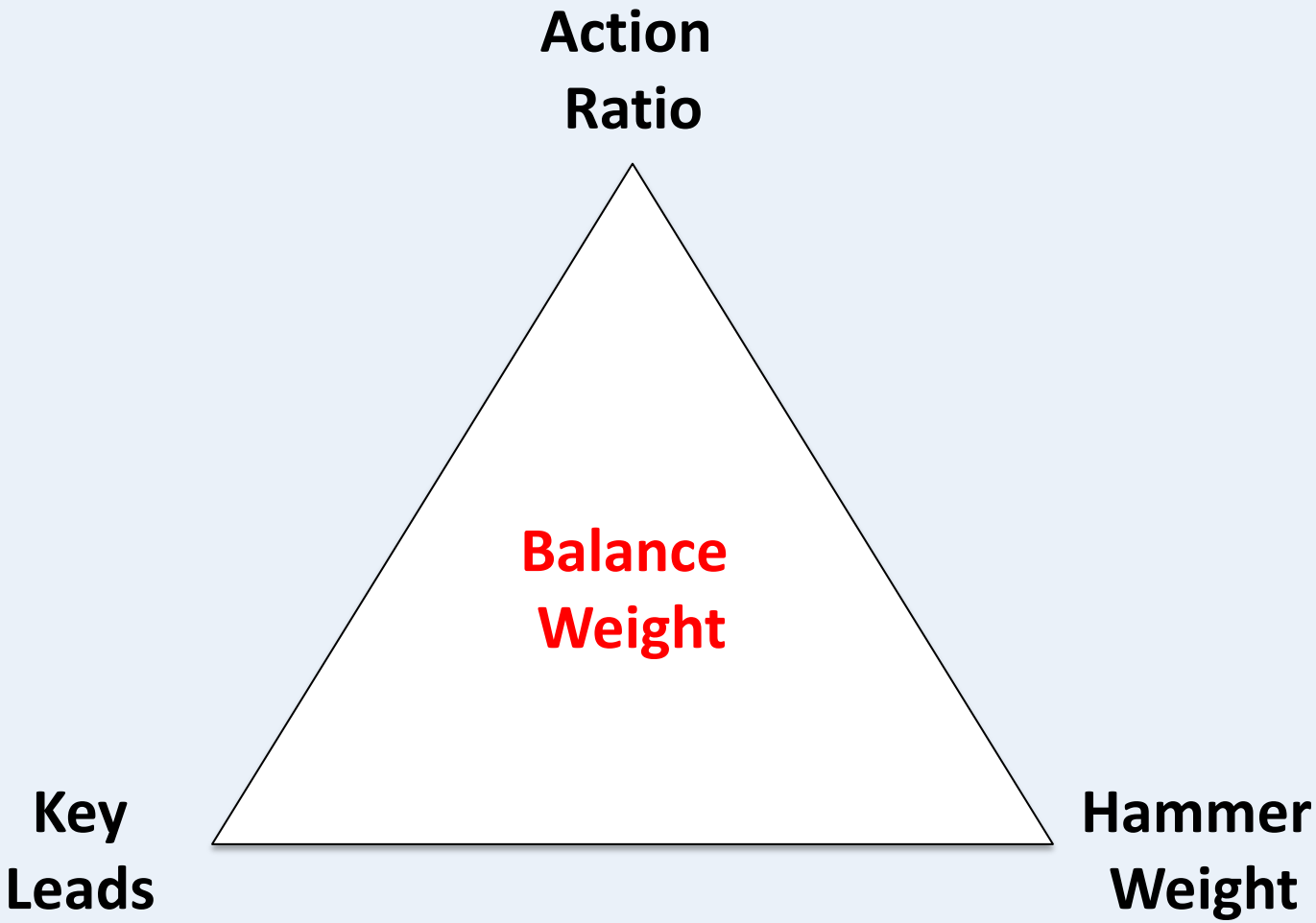
Correct Design!

Fresh Wood!

Stronger Key!

Freedom to establish lead pattern!

No lead or capstan holes to fill!



What About Inertia?

Explanation of Balance Weight

"The balance weight is equivalent to the force of gravity the pianist feels at the key…There is an additional weight factor – inertia"

David Stanwood PTGJ 11/1990

Understanding Inertia

"Changes in the total weight of the parts on either side of the key's fulcrum affects both the inertia and the balance weight."

David Stanwood PTGJ 11/1990

Managing Inertia
On Both Sides of the Fulcrum

Lead in Keys: What position & How Many?

Hammer Weight: How Heavy?

Action Ratio: Always Measure First!

Understanding Inertia

"If we are to create uniform touch resistance, then we must create uniform inertia…"

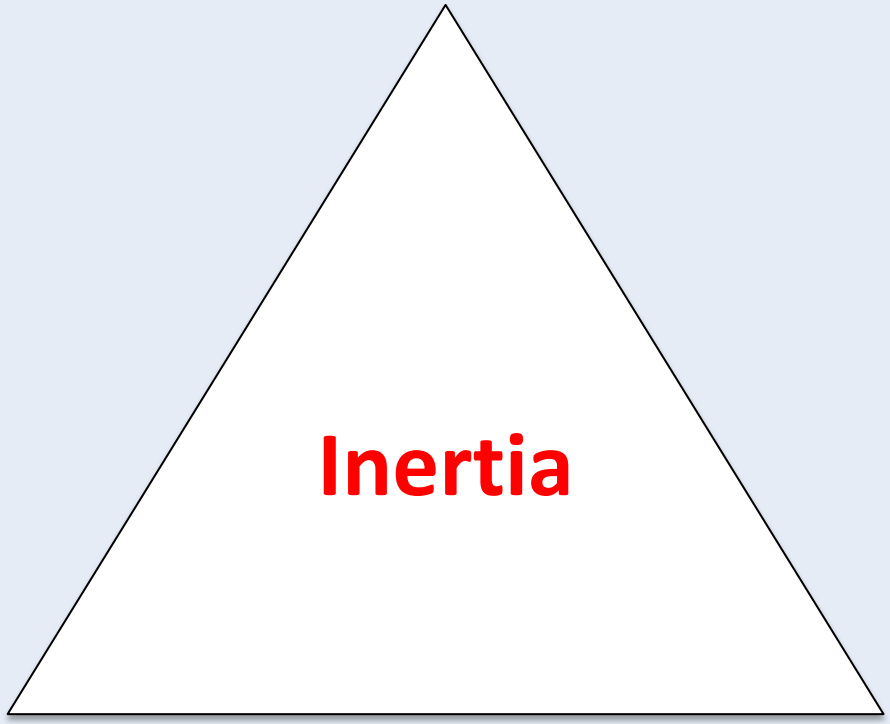
David Stanwood PTGJ 11/1990

Understanding Inertia

"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

Action Parts

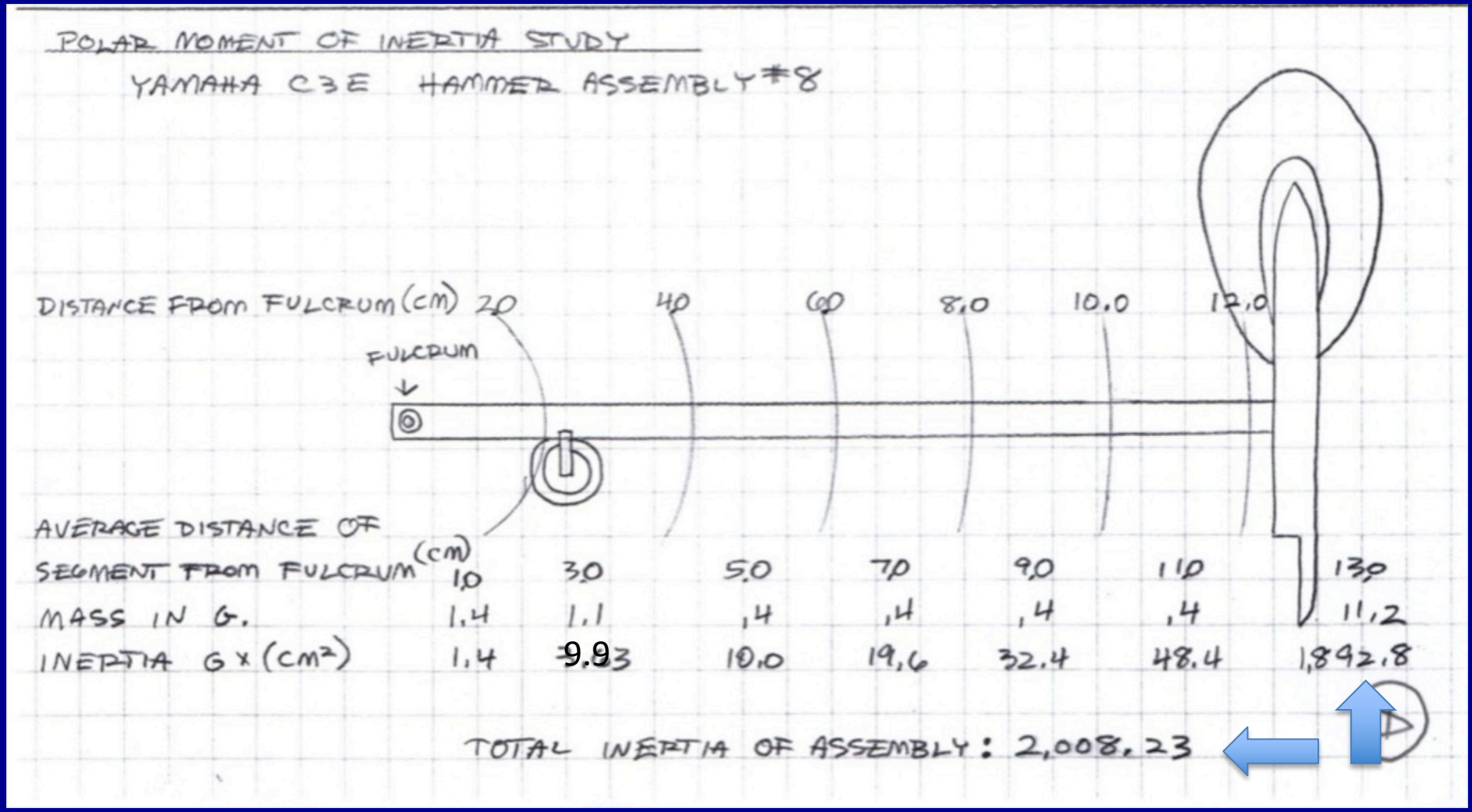


Key Lead

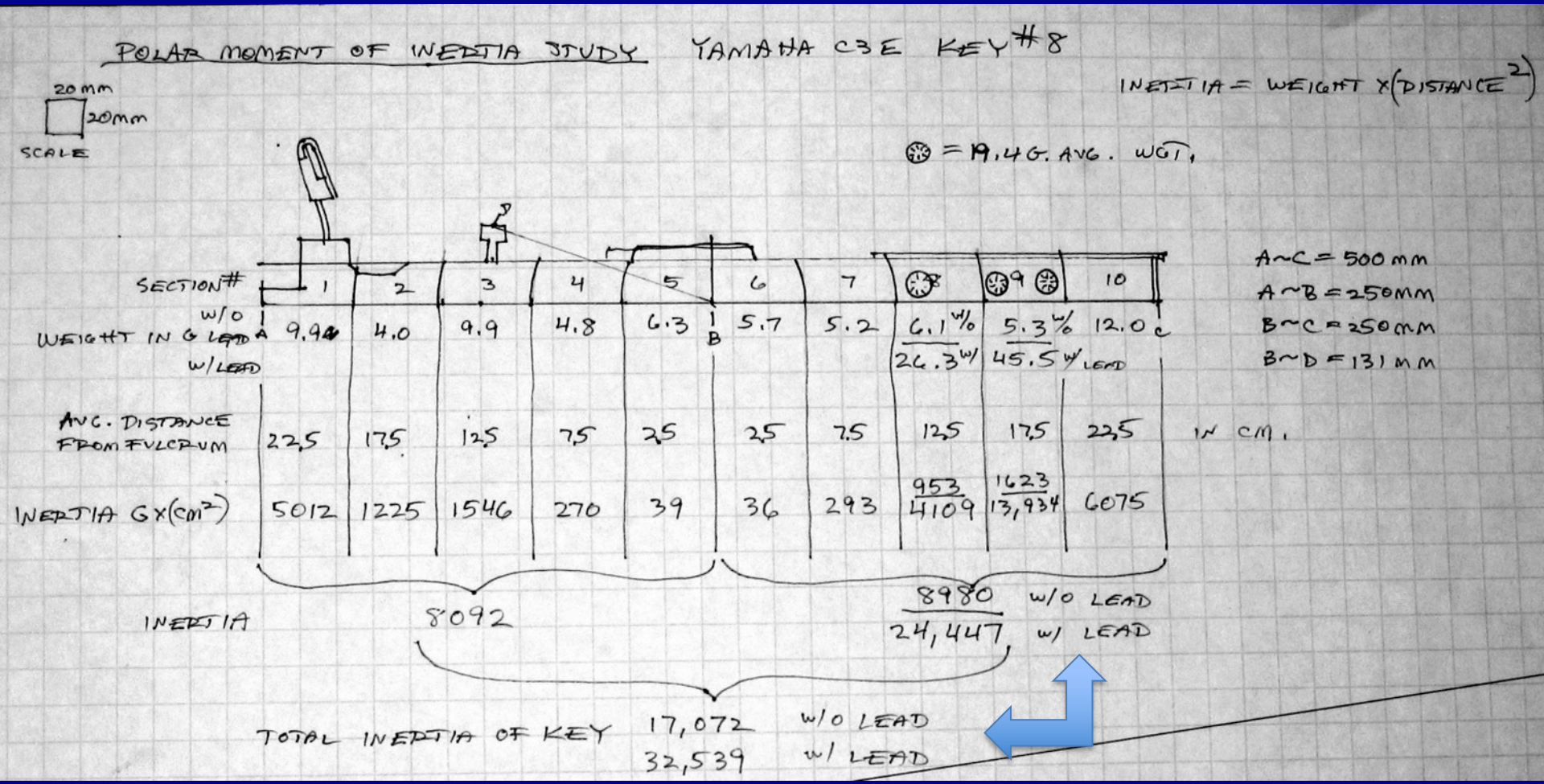
Hammers

Moment of Inertia = grams x cm^2

Effect of Weight of Shank & Hammer



Effect of the Key Mass



Lowering Inertia
Brass Capstans vs. WN&G Capstans

	Before	*After*
E2	22 f- 11g 27 bw- 38g	21 f- 10.5 25 bw- 36g
F2	20 f- 10g 28 bw- 38g	19 f- 9.5 26 bw- 36g

Brass 5.3g WN&G 1.4g

$$I = g \times cm^2$$

Balance Pin To Capstan

Brass – 828.13 WN&G – 218.75

Moment of Inertia Change – 609.38

Remove 3g from Front Lead
Raise Balance Weight: 36g to 38g

$I = g \times cm^2$

Before

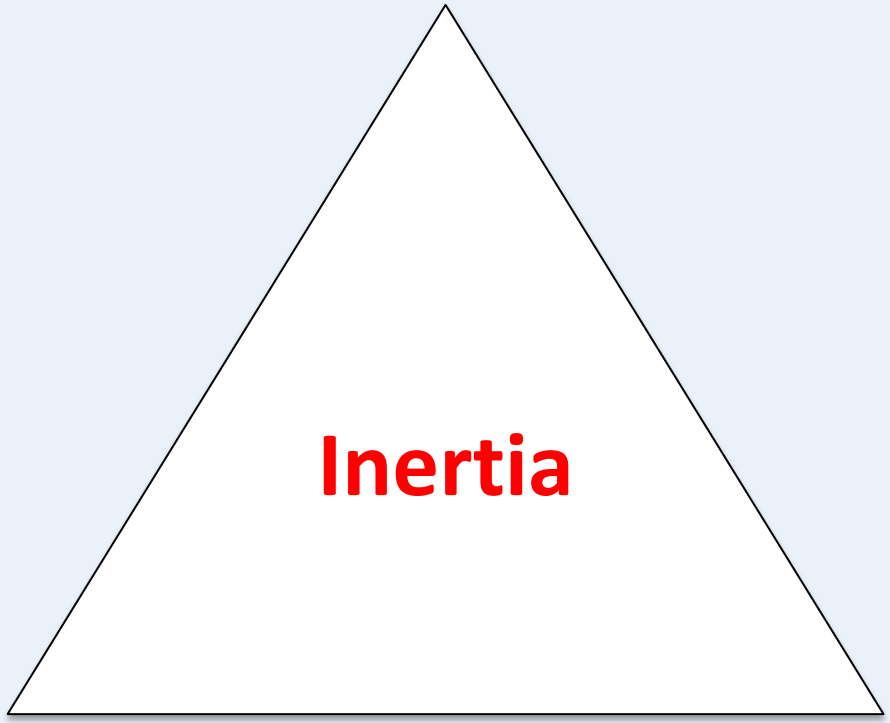
$14.1g \times 20cm^2 = 5{,}640$

After

$11.1 \times 20cm^2 = 4{,}440$

Total Moment of Inertia Change (Lead & Capstan) – 1809.38

Hammer Weight
[Weight of all Action Parts]

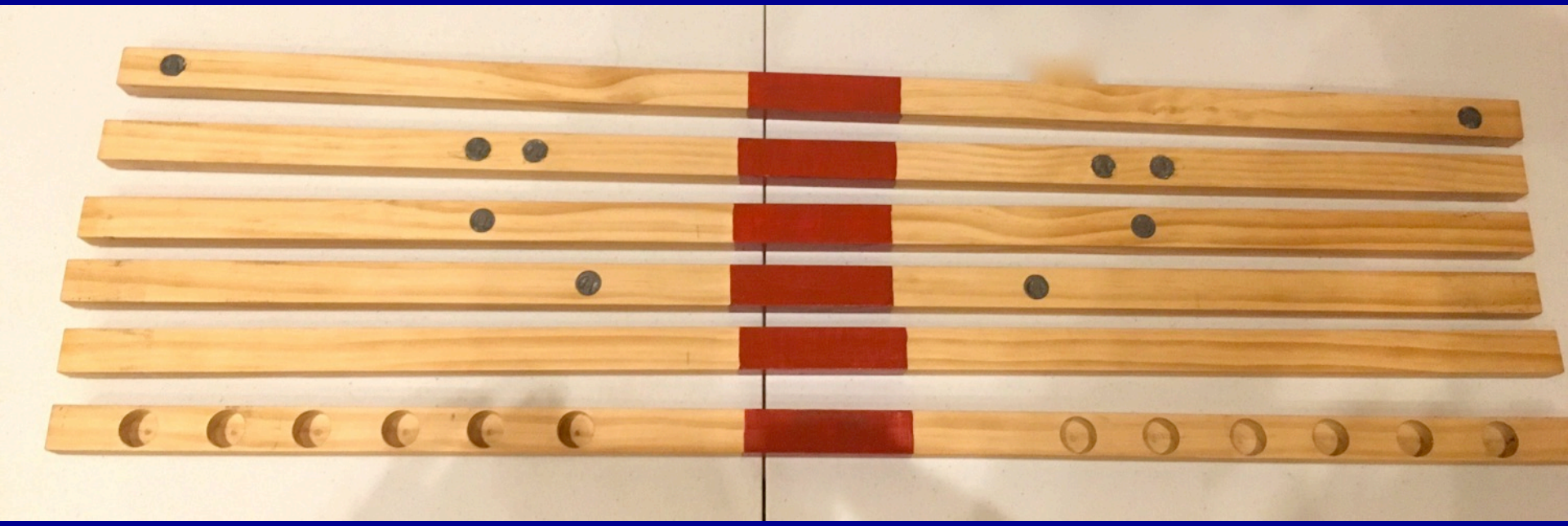


Amount &
Position of
Key Lead, etc.

Velocity
of Touch

Moment of Inertia = grams x cm^2

Piano Technicians Playground
2017 PTG Convention – St. Louis
Inertia Demonstration

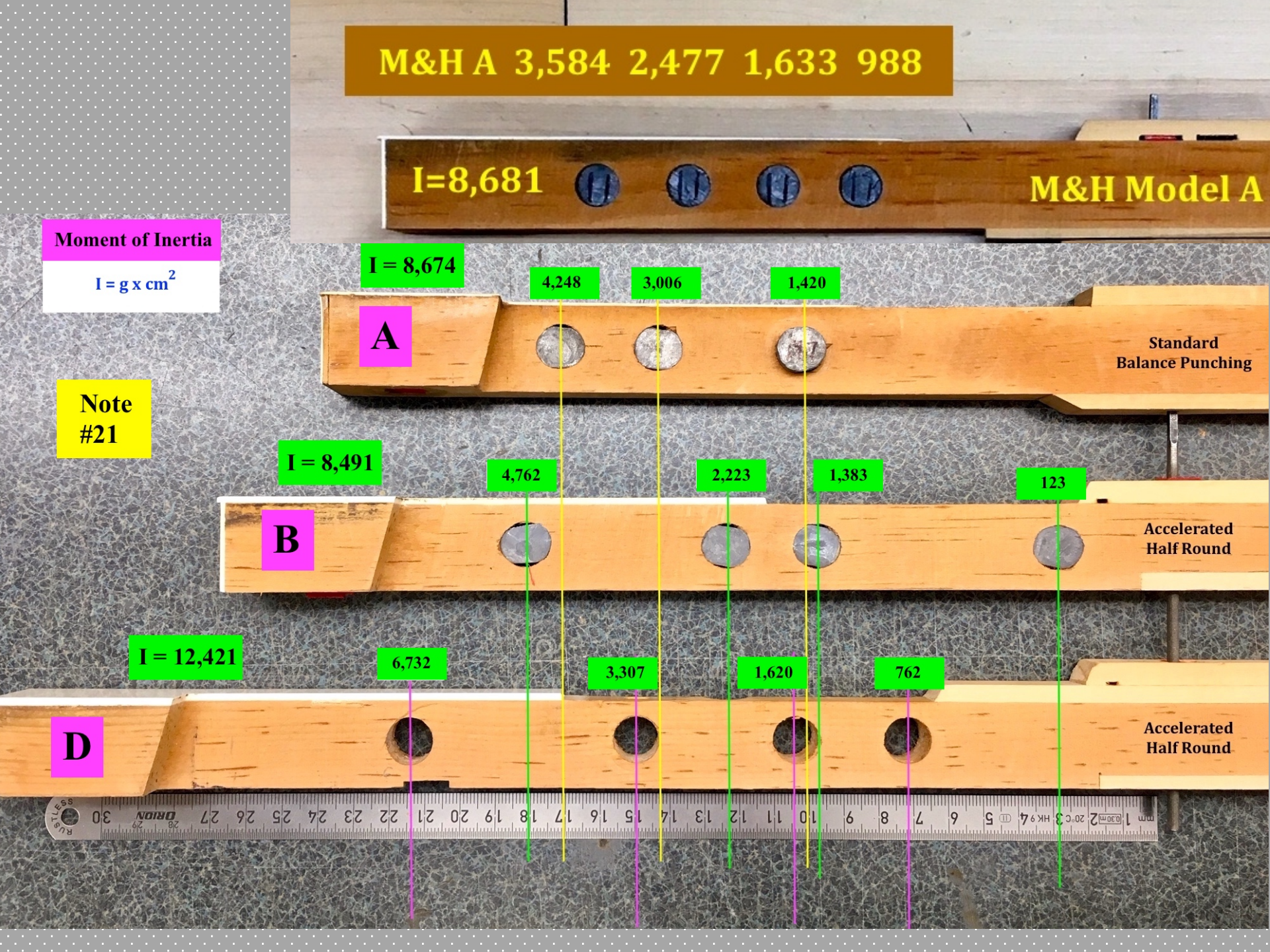


Inertia = Grams x Centimeters^2

Standard Leading Style vs. Accelerated Leading Style?

Steinway - Note #21
Models: A (SMOL) B, C & D

What is the inertial significance of each lead?


M&H A 3,584 2,477 1,633 988
I=8,681
M&H Model A
Moment of Inertia
I = g x cm 2
Note #21
I = 8,674
4,248
3,006
1,420
A
Standard Balance Punching
I = 8,491
4,762
2,223
1,383
123
B
Accelerated Half Round
I = 12,421
6,732
3,307
1,620
762
D
Accelerated Half Round


Steinway A, B & D
Note 21
Moment of Inertia
Consideration
I = 14.7g x cm2
A
(SMLO)
B
9,802
8,118
6,482
5,031
3,763
2,679
1778
1062
529
D
14.7g

Limits for Front Lead?