



Lets Talk Bushings

Chapter 6, February 26, 2023, Meeting

Edited by Raymond Fowler

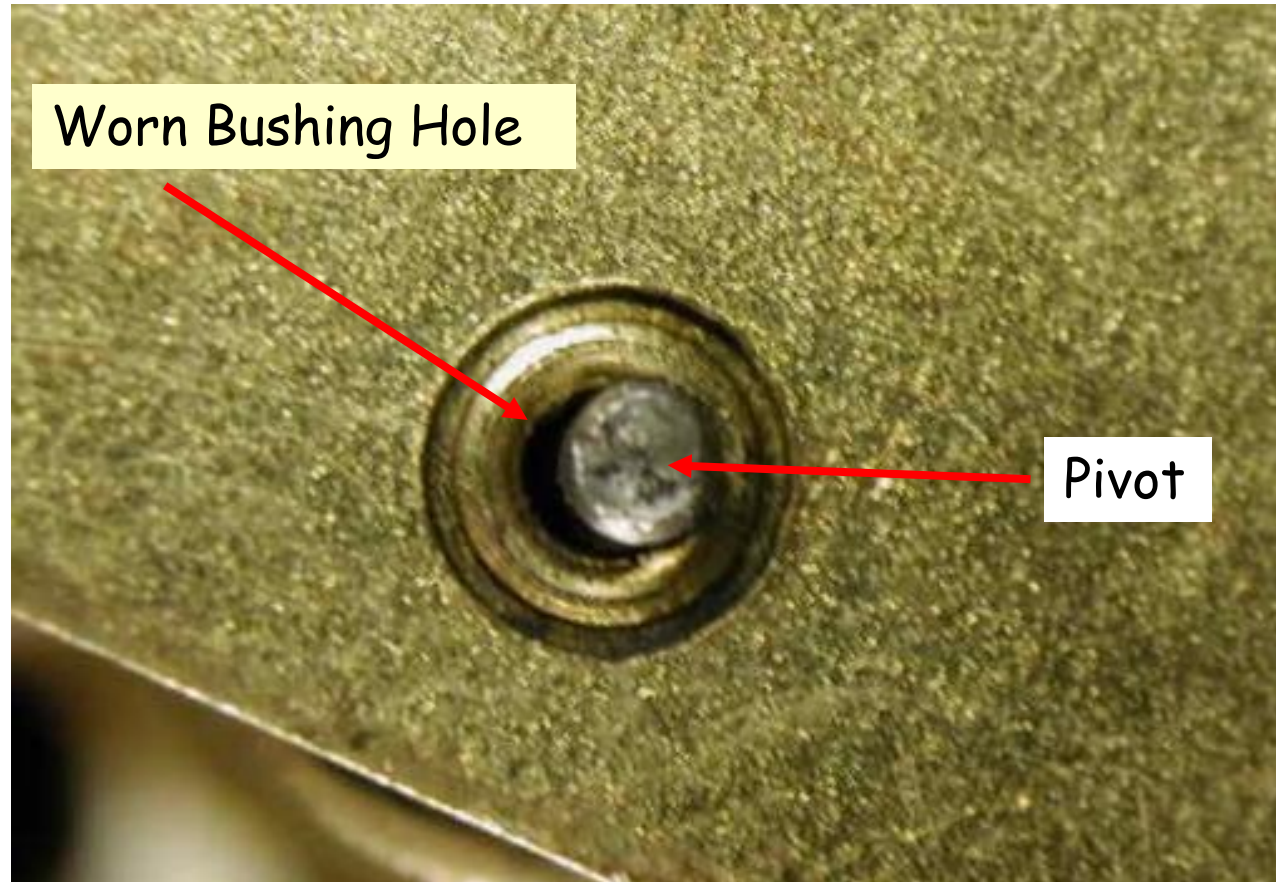
With Permission from Gary Combs, NAWCC Field Suitcase Instructor

More Definitions

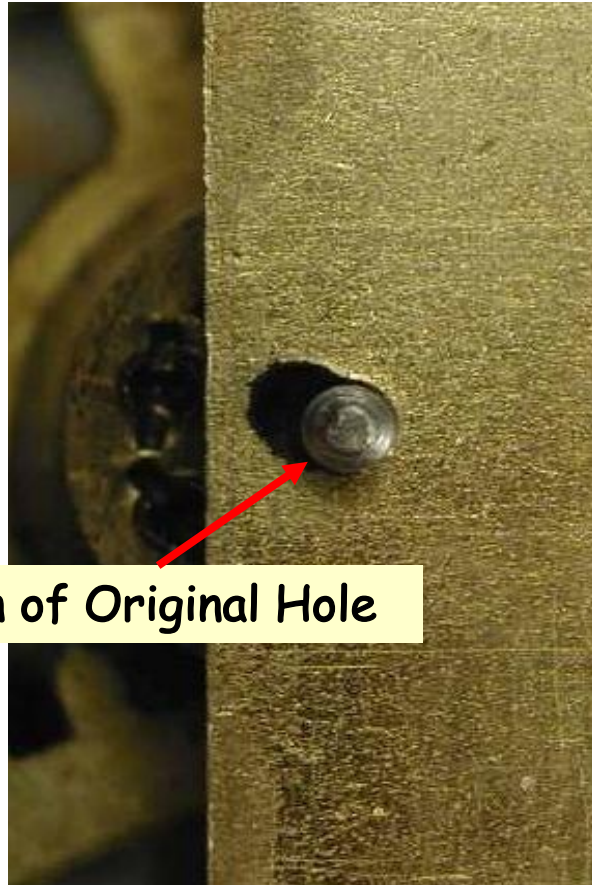
Bushing holes are the bearing surfaces of the clock plate



Typical Example of a worn Bushing

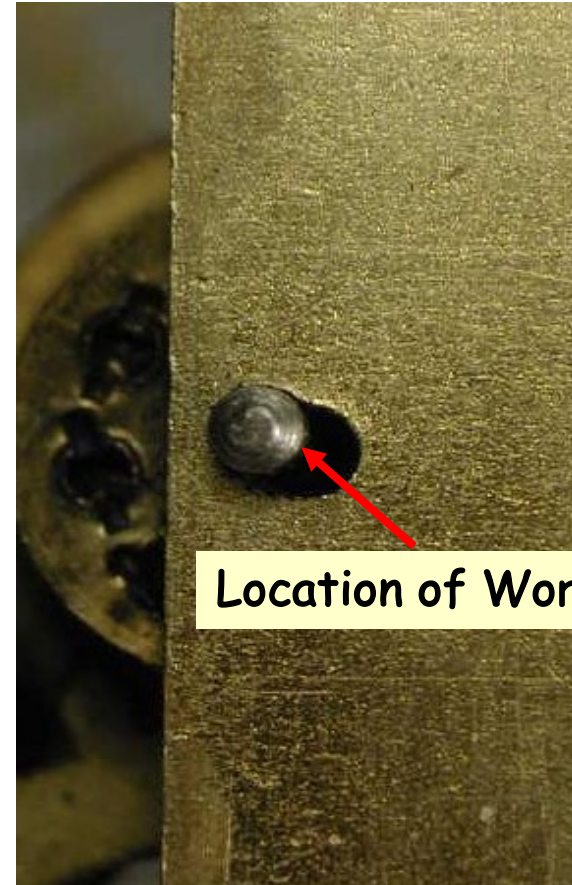


Examples of a Worn Pivot Hole



Location of Original Hole

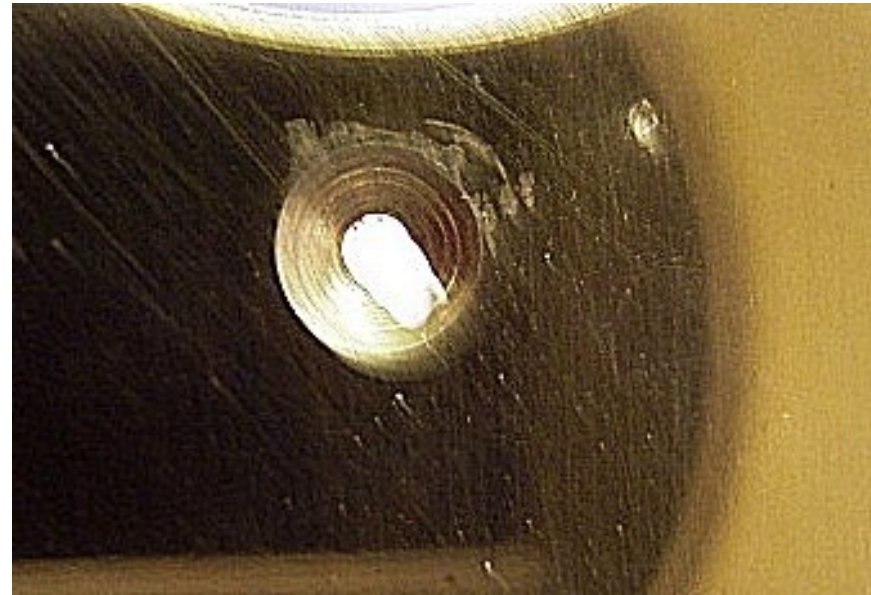
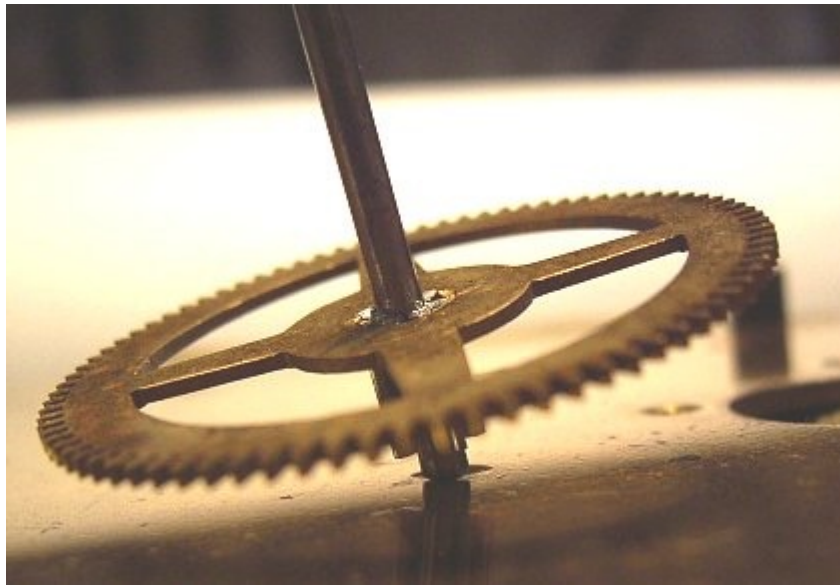
No Power on Movement



Location of Worn Area

Power applied

Needs bushing

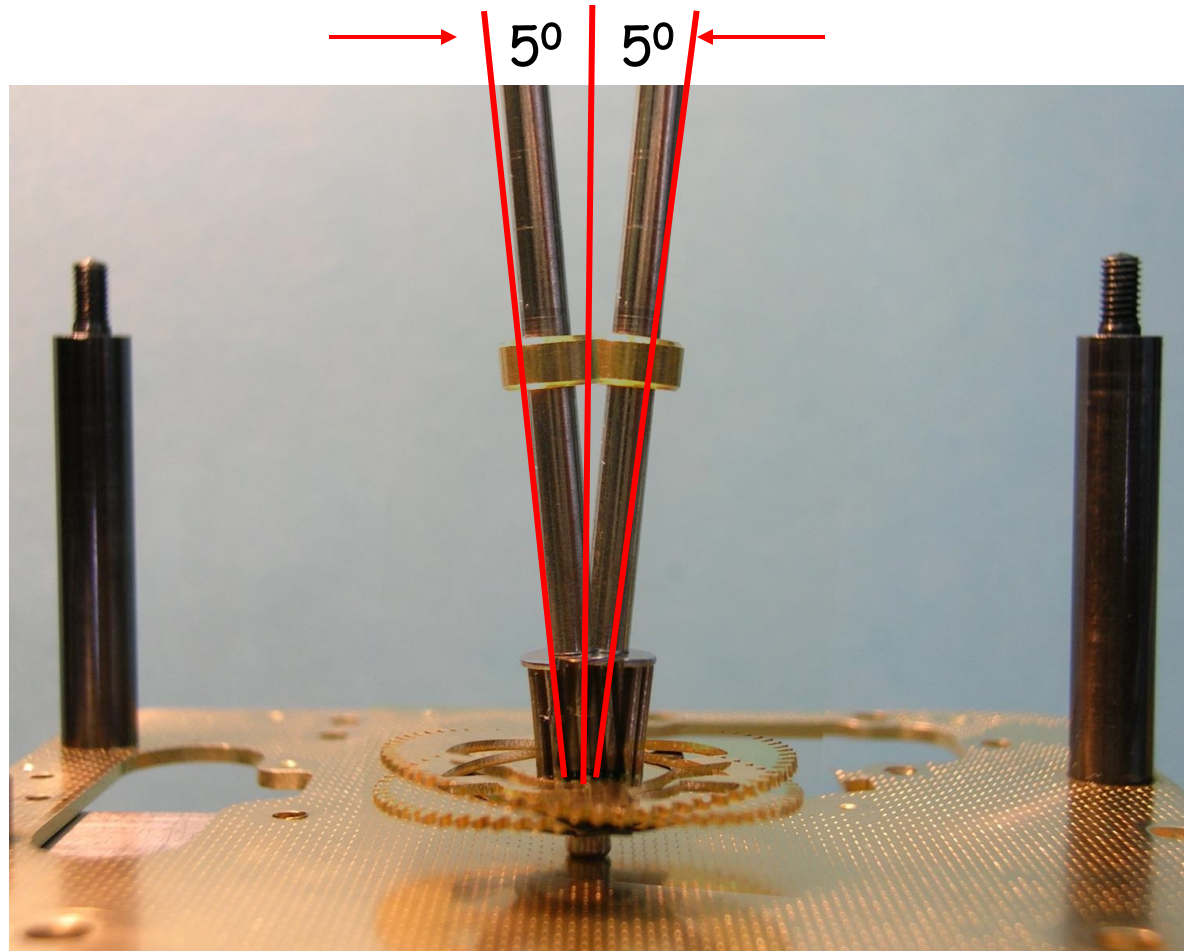


Bushing Replacement Criteria

- **In many cases the decision to replace a bushing is a judgment call based on many factors:**
 - **Degree of wear and/or surface condition**
 - **Location in train**
 - **Type of clock**
 - **Wheel and pinion teeth depthing**

Angle of Wheel Arbor Test

- Arbor leans due to bushing wear
- Lean criteria is $\gt \pm 5$ degrees
- Difficult criteria to judge
 - * ± 5 degrees
 - * 1-3mm plates
- It does work with experience



Which Bushing System **KWM** or **Bergeon**?

- **Both Bushing Systems are:**
 - **European.**
 - **Dimensioned in millimeters.**
 - **Can be used with bushing tools.**
 - **Or with an inexpensive hand operated tool.**
- **Bushings are not:**
 - **Interchangeable, but both Systems offer reamers that adapt bushings to the other's bushing tools.**

Both Systems are very good and recommended

Bergeon Bushing Tool

- Old Add, Same Machine! New Price For 2023 \$1150.

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KWM CLOCK BUSHING TOOL

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KWM Clock Replacement Bushings —
 "L" Sizes, Asst. Pack of 20 \$1.25
 "L" Sizes in Packs of 100 pcs. \$5.00

SWISS MADE

BERGEON Clock Bushings

#30092 Packs of 10 Pieces	\$1.00
#30093 Packs of 100 Pieces	\$5.50
# 4166 Box of 225 Bronze Bushings, By Separate Sizes Only	\$15.00
#30089 Wooden Box With 750 Bergeon Bushings	Only \$55.00
#5488-450 Brass Bushings. All 60 Sizes	Only \$25.00
#5701 1500 Bergeon Brass Bushings, in Wooden Box	60 Sizes ... \$87.50

Bergeon Bushings



Bergeon Bushing Guide

Bergeon Bushing Chart

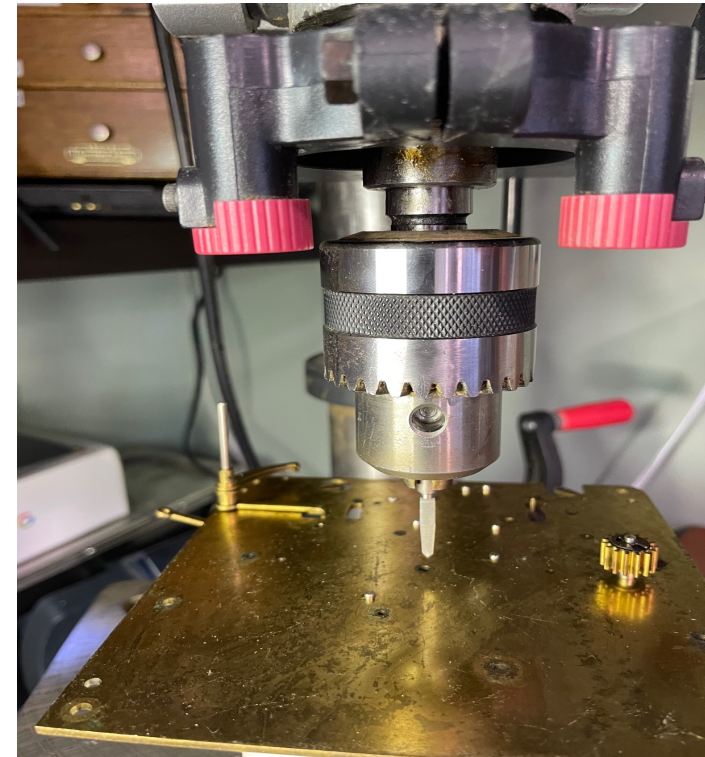
Size of Pinion - MM	0.3	0.35	0.4	0.45	0.5	0.55	0.6	0.65	0.7	0.75	0.8	0.85	0.9	0.95	1	1.1	1.2	1.25	1.3	
Thickness of Plates	1.5																			
Bushing # / Cutter #	#31 / 1	#32 / 1	#1 / 1	#34 / 1	#2 / 1	#37 / 1	#3 / 1		#5 / 1		#7 / 2		#9 / 2	#41 / 2	#11 / 3				#13 / 3	
Thickness of Plates	2																			
Bushing # / Cutter #			#33 / 1		#15 / 1			#18 / 1		#39 / 1		#40 / 2			#42 / 3	#43 / 3	#44 / 3	#45 / 3	#46 / 3	
Thickness of Plates	3																			
Bushing # / Cutter #					#36 / 1		#4 / 1		#6 / 1		#8 / 2		#10 / 2		#12 / 3				#14 / 3	
Size of Pinion - MM	1.4	1.5	1.6	1.65	1.7	1.75	1.8	1.9	2	2.1	2.25	2.4	2.5	2.75	3	4	5	6	6.5	
Thickness of Plates	1.5																			
Bushing # / Cutter #		#15 / 4	#49 / 4			#17 / 4			#19 / 5		#21 / 5		#23 / 5		#25 / 6	#27 / 7				
Thickness of Plates	2																			
Bushing # / Cutter #	#17 / 4	#48 / 4		#50 / 4	#51 / 4		#52 / 4	#53 / 4	#54 / 5	#55 / 5	#56 / 5	#57 / 5		#58 / 5						
Thickness of Plates	3																			
Bushing # / Cutter #		#16 / 4				#18 / 4			#20 / 5		#22 / 5		#24 / 5		#26 / 6	#28 / 7	#28 / 7	#30 / 9		

Using Drill Press

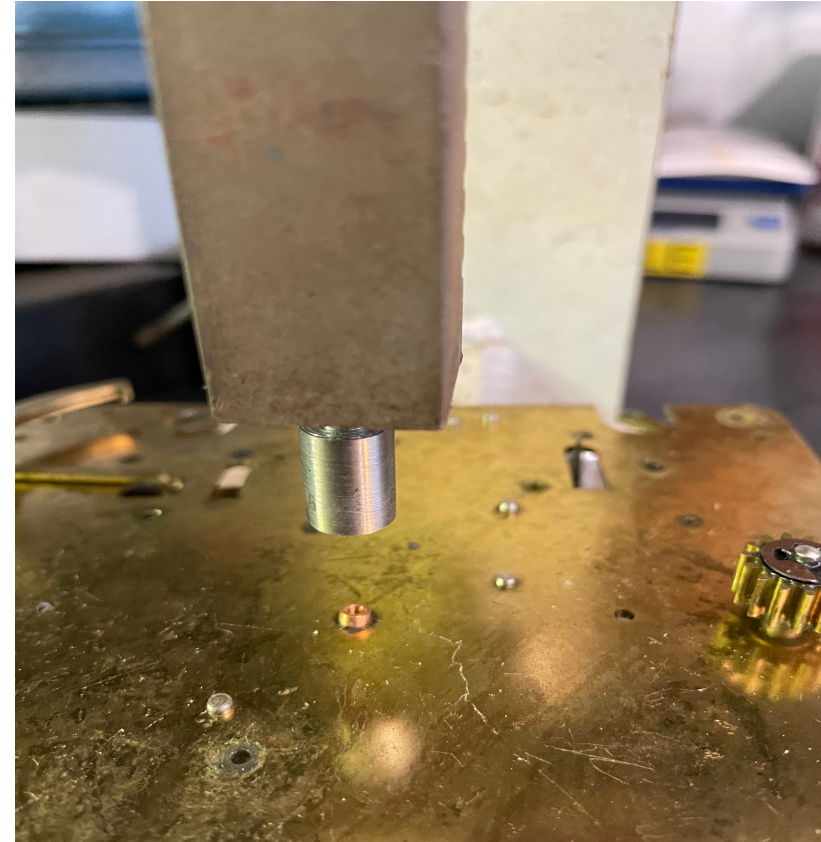
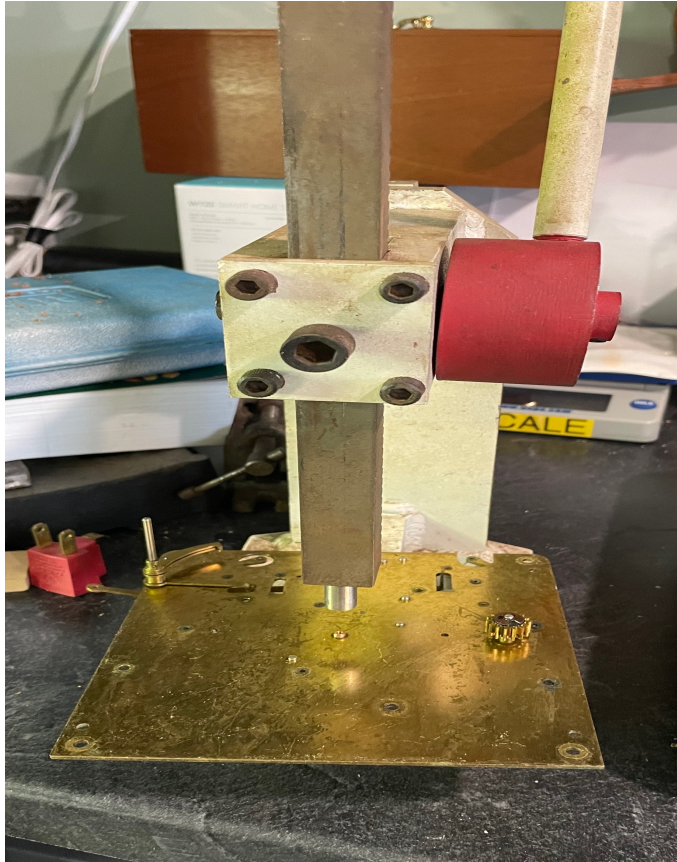
Checking with Square



Cutting Plate for Bushing



Using Arbor Press

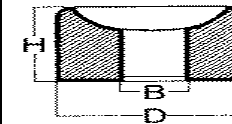


A KWM Bushing Tool With Accessories



KWM Bushing Sheet

Z Pivot Diameter	Bore	H D R R N	1.0		1.4				1.7		1.9			2.7			3.0		4.0	
			1.2	1.8	1.8	2.7	3.5	4.7	5.9	5.9	1.8	2.7	3.5	1.8	2.7	3.5	4.7	5.9	3.0	4.0
			I	II	II	III	IV	IVa	V	V	II	III	IV	II	III	IV	IVa	V	VI	VI
0.07-0.08	0.1		L55																	
0.10-0.12	0.15		L56																	
0.15-0.17	0.2		L01																	
0.19-0.21	0.25		L57																	
0.23-0.25	0.3		L02		L64															
0.27-0.30	0.35		L58							L86										
0.32-0.35	0.4		L03		L08					L87										
0.38-0.40	0.45		L59																	
0.42-0.45	0.5		L04		L09					L32				L94						
0.48-0.50	0.55		L60																	
0.53-0.55	0.6		L05		L10					L33				L95						
0.57-0.60	0.7		L06		L11					L34				L96						
0.65-0.70	0.8		L07		L12					L35				L97						
0.75-0.80	0.9			L61	L13					L36				L98						
0.85-0.90	1.0			L62	L65	L14				L37				L99						
0.95-1.00	1.1			L63	L66	L15					L38			L100						
1.05-1.10	1.2					L16					L39			L101						
1.15-1.20	1.3					L17					L40			L102						
1.25-1.30	1.4					L18					L41			L103						
1.35-1.40	1.5					L19					L42			L104						
1.45-1.50	1.6					L20					L43			L105						
1.55-1.60	1.7					L67					L88			L106						
1.65-1.70	1.8					L21					L44			L107						
1.75-1.80	1.9					L68					L89			L108						
1.85-1.90	2.0							L22				L45		L109						
1.95-2.00	2.1							L69				L90		L110						
2.05-2.10	2.2							L23				L46		L111						
2.15-2.20	2.3							L70				L91		L112						
2.25-2.30	2.4							L24				L47		L113						
2.35-2.40	2.5							L71				L92		L114						
2.45-2.50	2.6							L25				L48		L115						
2.55-2.60	2.7							L72				L93		L116						
2.65-2.70	2.8							L26				L49		L117						
2.75-2.80	2.9								L138	L73	L80				L143					
2.85-2.90	3.0								L139	L27	L50				L144	L118				
2.95-3.05	3.2								L140	L28	L51				L145	L119				
3.10-3.25	3.4								L141	L74	L81				L146	L120				
3.30-3.45	3.6								L142	L29	L52				L147	L121				
3.55-3.65	3.8									L75	L82					L122				
3.75-3.85	4.0									L76	L83					L123				
3.90-4.05	4.2									L30	L53					L124				
4.15-4.25	4.4									L77	L84					L125				
4.35-4.45	4.6									L31	L54					L126				
4.55-4.65	4.8									L78	L85					L127				
4.75-4.85	5.0																	L128		
5.00-5.05	5.2																	L129		
5.15-5.25	5.4																	L130		
5.35-5.45	5.6																	L131		
5.55-5.65	5.8																	L132		
5.75-5.85	6.0																	L133		
5.95-6.05	6.2																		L134	
6.15-6.25	6.4																		L135	
6.35-6.45	6.6																		L136	
6.55-6.65	6.8																		L137	



How to use this chart
 The numbers prefixed by the letter "L" such as L57 in the chart indicates the bushing number. The number serves as a refill number for various assortments. To select the correct bushing, first Measure the pivot, & find it size in the range of sizes shown in column Z. By reading across, you Will find the various bushing that Will fit the size pivot.
 Select the thickness of bushing by Referring to letter "H" & the correct diameter by the letter "D". After choosing the bushing, read Up the column to line "RN" which indicates the size reamer to Be used for the selected bushing. Reamers are identified by Roman numerals.

KWM Bushing Template

ZAPFENMASS
PIVOT GAUGE

(K·W·M)

Bohrung · Hole	0,1	0,15	0,2	0,25	0,3	0,35	0,4	0,45	0,5	0,55	0,6	0,7	0,8	0,9	1,0	1,1	1,2	1,3	1,4	1,5	1,6	1,7	
Höhe · Height 1,0	L55 ¹	L56 ¹	L01 ¹	L57 ¹	L02 ¹	L58 ¹	L03 ¹	L59 ¹	L04 ¹	L60 ¹	L05 ¹	L06 ¹	L07 ¹	L61 ²	L62 ²	L63 ²							
Höhe · Height 1,4					L64 ²		L08 ²		L09 ²		L10 ²	L11 ²	L12 ²	L13 ²	L65 ² L14 ²	L66 ² L15 ²	L16 ²	L17 ²	L18 ²	L19 ²	L20 ²	L67 ²	
Höhe · Height 1,9					L86 ²		L87 ²		L32 ²		L33 ²	L34 ²	L35 ²	L36 ²	L37 ²	L38 ²	L39 ²	L40 ²	L41 ²	L42 ²	L43 ²	L88 ²	
Höhe · Height 2,7									L94 ²		L95 ²	L96 ²	L97 ²	L98 ²	L99 ²	L100 ²	L101 ²	L102 ²	L103 ²	L104 ²	L105 ²	L106 ²	
Masse in Millimeter	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	
Bohrung · Hole	1,8	1,9	2,0	2,1	2,2	2,3	2,4	2,5	2,6	2,7	2,8	2,9	3,0	3,2	3,4	3,6	3,8	4,0	4,2	4,4	4,6	4,8	
Höhe · Height 1,4	L21 ²	L68 ²	L22 ²	L69 ²	L23 ²	L70 ²	L24 ²	L71 ²	L25 ²	L72 ²	L26 ²	L73 ²	L27 ²	L28 ²	L74 ²	L29 ²	L75 ²	L76 ²	L30 ²	L77 ²	L31 ²	L78 ²	
Höhe · Height 1,7											L79 ²	L80 ²	L50 ²	L51 ²	L81 ²	L52 ²	L82 ²	L83 ²	L53 ²	L84 ²	L54 ²	L85 ²	
Höhe · Height 1,9	L44 ²	L89 ²	L45 ²	L90 ²	L46 ²	L91 ²	L47 ²	L92 ²	L48 ²	L93 ²	L49 ²												
Höhe · Height 2,7	L107 ²	L108 ²	L109 ²	L110 ²	L111 ²	L112 ²	L113 ²	L114 ²	L115 ²	L116 ²	L117 ²		L118 ²	L119 ²	L120 ²	L121 ²	L122 ²	L123 ²	L124 ²	L125 ²	L126 ²	L127 ²	
Measurements in Millimeter	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	

MADE IN GERMANY

This template contains the same info as the table

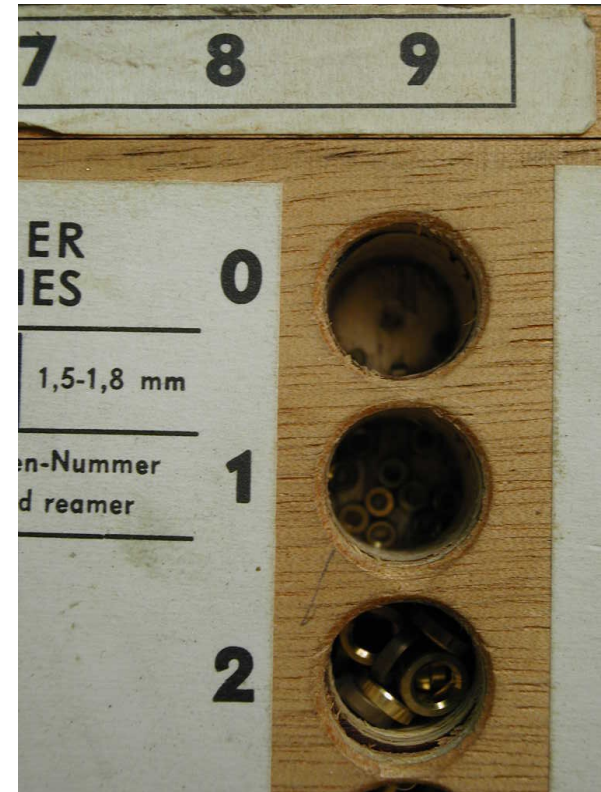
KWM Bushings



KWM Bushings



Select a Bushing



Reaming Hole for New Bushing



Reamer in Hole



Hole Ready for Bushing



Inserting Bushing in Hole



Bushing in Hole

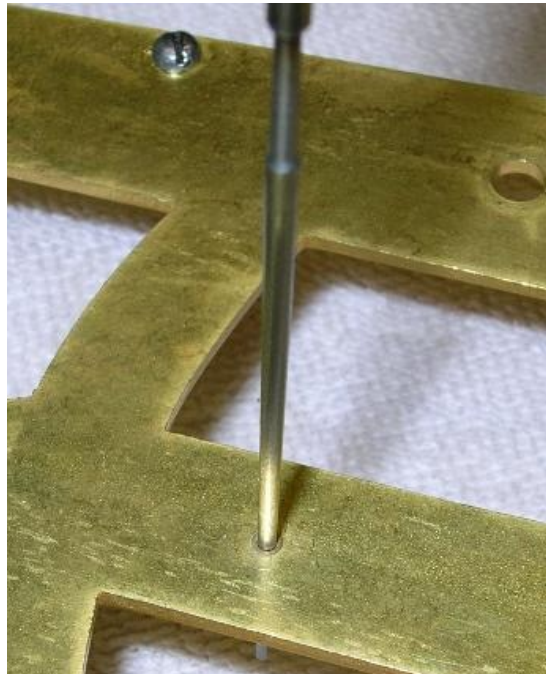


Bushings: Final Fit

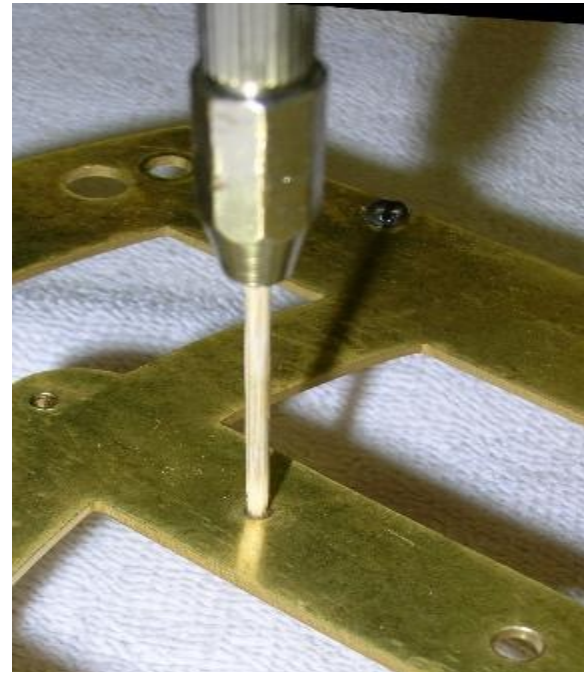
- **Bush tight and broach to final fit**
- **Every wheel needs clearance to spin**
 - **Side shake and end shake**
- **Broaches**
 - **Cutting From Both Sides**
 - **5-sided with taper**
 - **To enlarge the bushing hole for pivot clearance**
 - **Used dry**
 - **Twist with very light pressure to remove a little material at a time**
 - **Monitor results often**
 - **Maintain upright**
 - **Smoothing**
 - **Round with taper**
 - **To burnish and harden the bearing surface**
 - **Used with oil**
 - **Twist with light pressure. Do NOT jam into the bushing**

Burnish All Bushing Holes

All bushing holes need to be burnished with a smoothing broach and peg-wood or toothpick

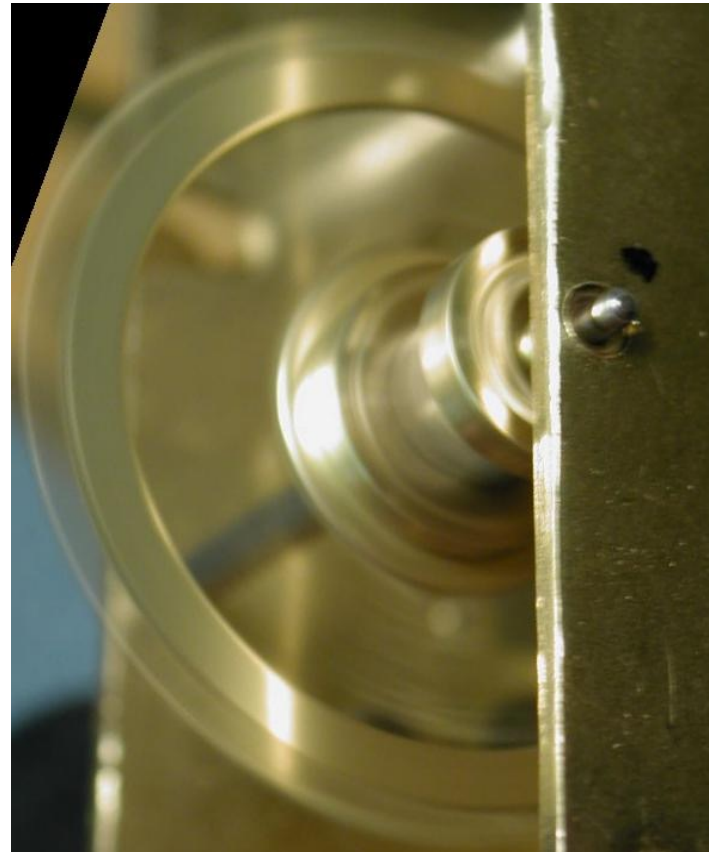
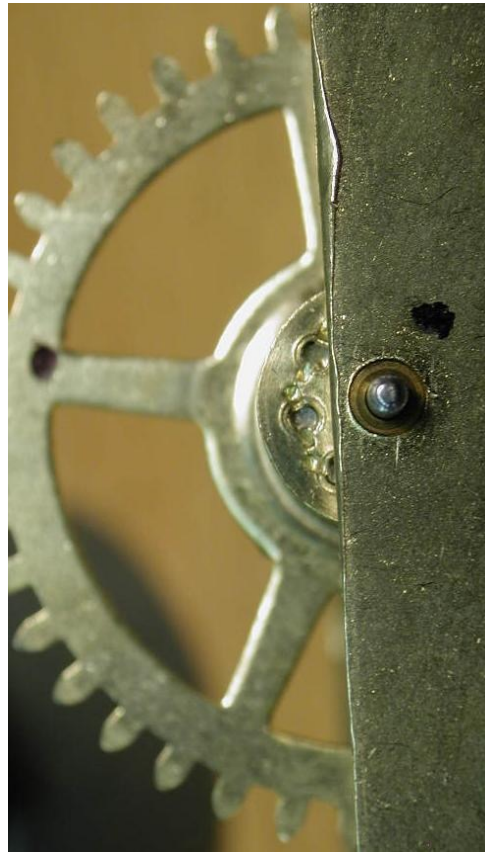


Use oil on smoothing broach



Burnish dry with wooden burnisher

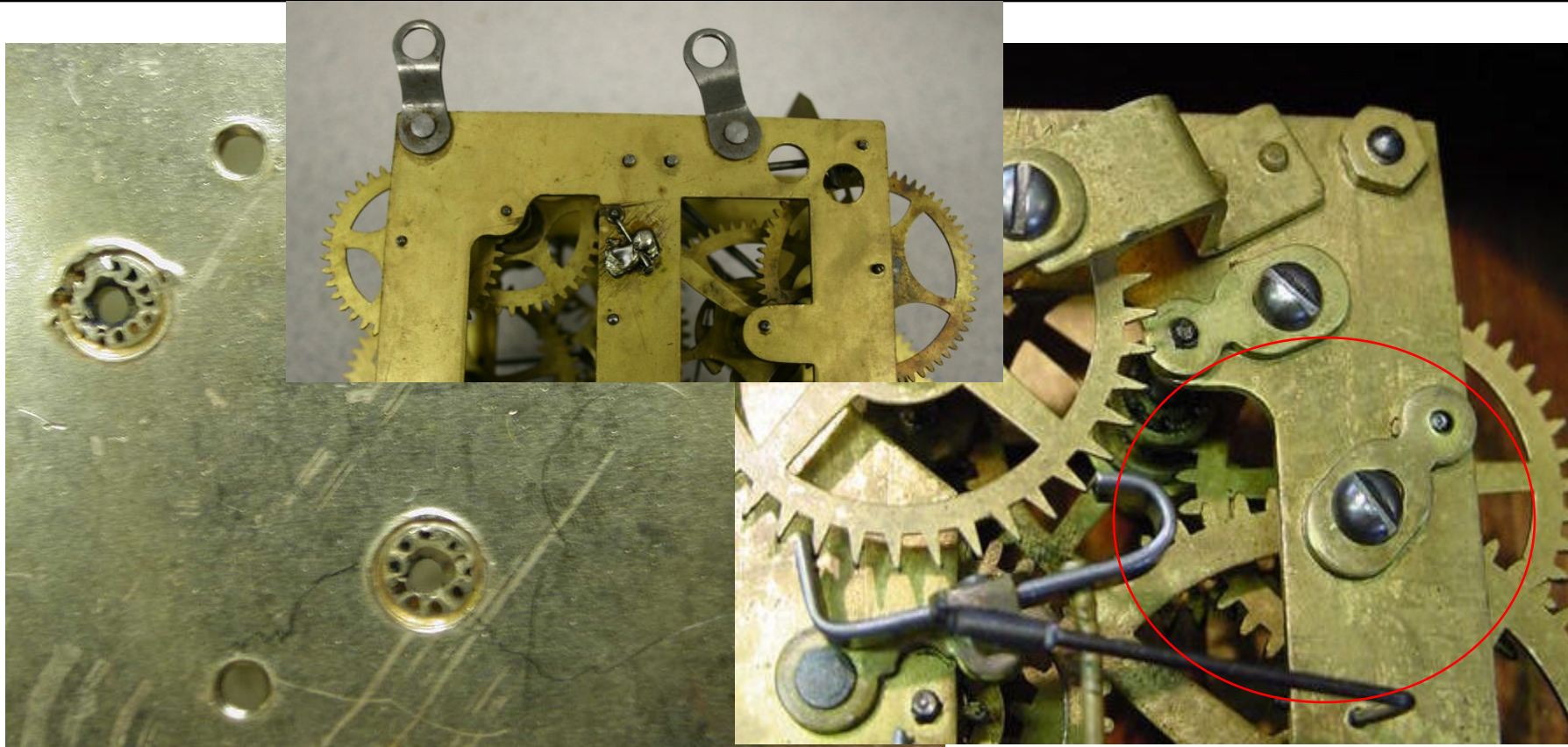
Testing New Bushing



Finally, Test all Wheels in the Train

- **Final test of the bushing job is to assemble all wheels in each train.**
- **Leave the verge off the time train and the levers out of the strike and chime train.**
- **Apply a small amount of power and wheels should turn freely.**
If not, look for:
 - **Bushings that are too tight**
 - **Bent pivots**
 - **Depthing issues**
 - **Too little end-shake**
 - **NEED to correct these issues now!**

Rathburn (band-aide) bushing tabs and Hole Closing are Destructive Practices



<http://masterclockrepair.com/hallofshame.html>