American Clock Movements: Restoration Lessons Learned

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NAWCC Chapter 21
Atlanta Chapter 24
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Disclaimer

- This is an immensely broad topic
- We will focus on:
  - Commonly encountered American, open spring wound movements only
  - Some of the topics could be courses
  - Many of the issues occur in other movements
- What's presented is my experience
  - There is latitude for other ideas

Preface

- Rumors (I have heard):
  - "American clocks not worth doing right."
  - "Give them to the apprentice."
  - "As long as it runs."
  - "Just keep a bone yard of old movements to steal parts from."

- What I encounter:
  - Pivots, hole wear not properly addressed
    - Butchery (Rathburns, soldered scabs, etc.)
    - Punched up holes (completely ineffective)
  - Incorrect mainsprings and suspension springs
  - Important wear elements neglected
  - Improper substitution parts that don't fit right

http://masterclockrepair.com/hallofshame.html

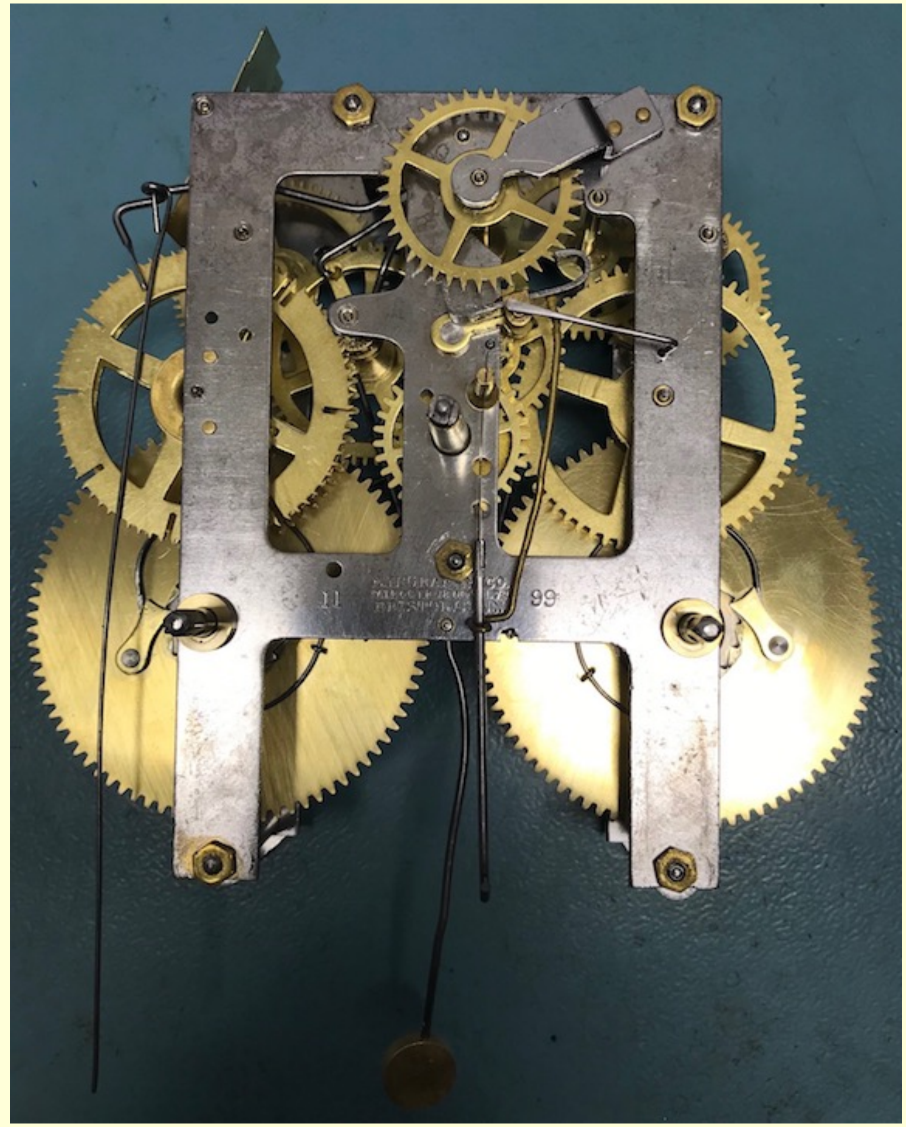
Observations on American Movements

(which have crossed my path)

- American clock movements are VERY MUCH worth doing right
  - If you don't, they'll be back very soon
  - Educate your customer
- Many ill-fitting replacement parts are indeed available
- Polished pivots last longer than not
  - Glass-smoothed burnished pivots last longest
  - Hourglass pivots and fit extended bushings—NO!
  - Poor pivot jobs cheat the customer
- Rathburns deface a movement permanently
- Improper mainsprings lead to massive work later
- Un-serviced worn main wheel bearings stop a clock
- Beat up clicks, ratchets, click springs can prove fatal
  - And can injure your customer
- If you are unsure about your skills, get help!

Our Host Clock

- Early Ingraham kitchen clock movement
  - Steel plates
- Required 12+ new parts fabricated
- Problem: Movement would not run reliably
  - Root cause covered multiple areas
- Special appearances by New Haven 300-series T/S
  - To help with illustrations



Cleaning

Recommended BEFORE inspection

- Disassembly is key! Do NOT clean movements assembled
  - Induces rust if water-based cleaner used
  - Doesn't cure wear issues
- American clocks responsive to Ammoniated cleaning solutions
- Heavy filth and dried oil clogging trundles, ratchets, holes
- 30-45 minutes in tank MAX; brass brush to loosen filth
- Rinse main wheels in IPA or Naphtha
- Blow dry with compressed air

Ammoniated Time-Tested Formula

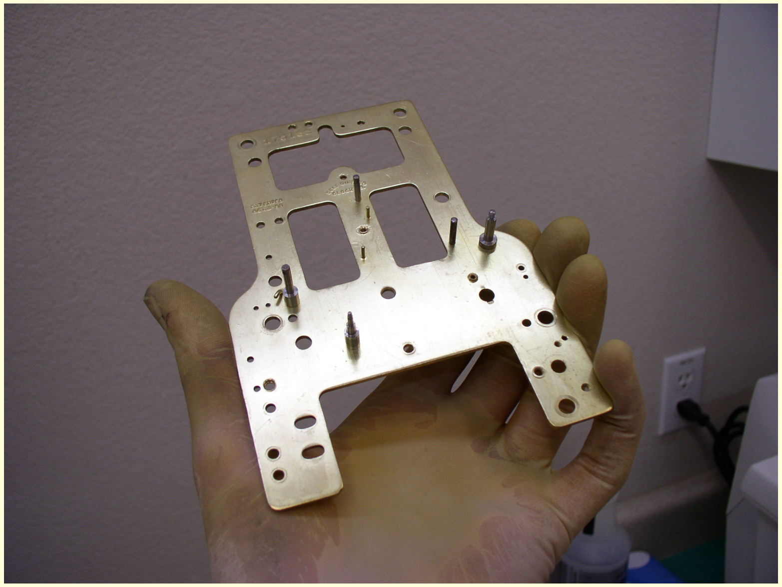
Updated 10/15/22

- 4 ounces Oleic Acid
- 4 ounces Pine Sol (original formula)
- 8 ounces Acetone
- 96 ounces Household ammonia (clear)
  - 20 oz if Commercial (27%)
  - 96 oz if Household (5-10%)
  - Add water to 1.5 gallons

- Mix oleic acid and acetone first
- Then add Pine Sol
- Finally, add Household Ammonia and water
- This mix makes 1.5 gallons—a good quantity for clock cleaning

Brushing

- Use brass bristle brush
- Cleans oxides away
  - Removes previous damage from finger oils and contaminants
- Better appearance
  - Pride of Craftsmanship
  - Makes it easier to see what you are working on later
- May need multiple passes



Brush Options

- German-made brass brushes
  - Available from Timesavers 14339 ($7.50)

- Brass and Nylon brushes available from others
  - Recommend Torrington 04046 ($6.98) brass
  - Consider Torrington 04124 ($4.60) black nylon

- Probably need all for various jobs

Proper Pivot Polishing

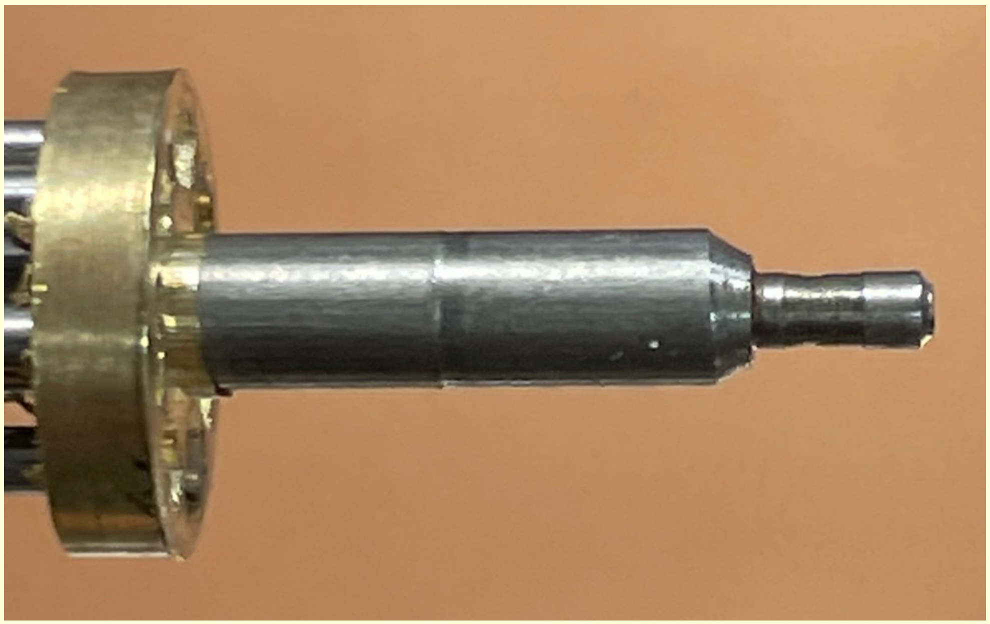
- Properly polished pivots last longer
- Rough finish will destroy holes
  - This in turn may destroy pivot
- Sometimes replacement needed
  - Sometimes easier to fab new arbor
- “Break” or polish pivot tips
  - Avoids scratching plates during reassembly
  - Pushes metal fragments into holes

Polishing Process

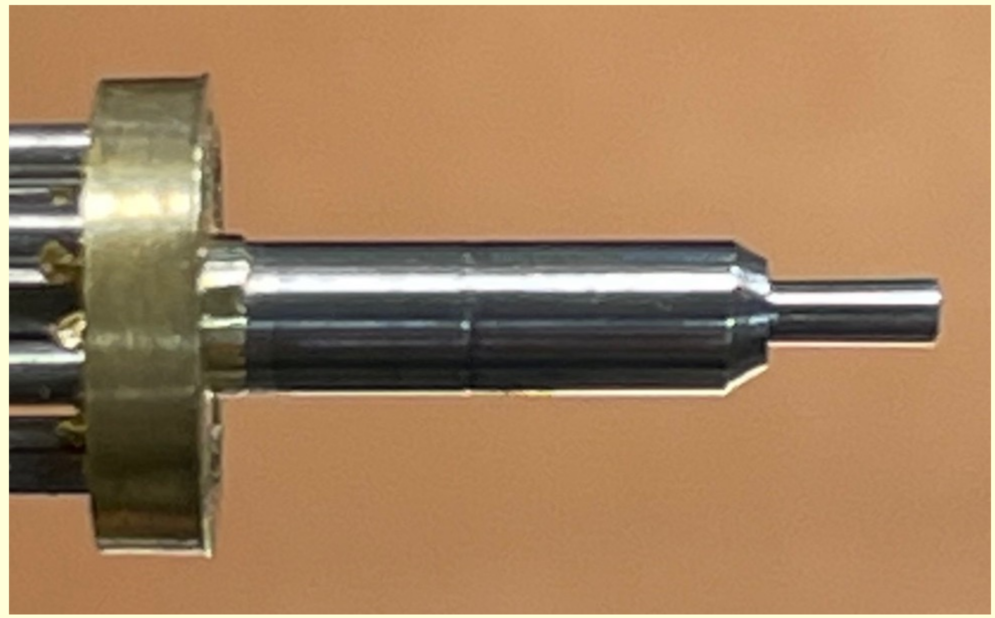
- Clean scoring away with Pivot File
  - DO NOT USE regular file; not designed with right cut
- Dress burnisher
  - 120-150 Emery Paper best
- Apply oil to burnisher
- Burnish thoroughly
- Need to repeat
- Use fingernail test
- Can finish with Flitz on popsicle stick

Pivot Polishing

Before/After

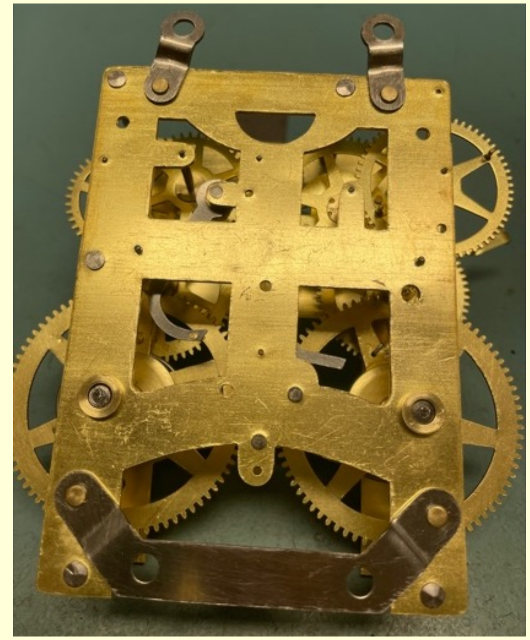


Before



After

Inspection



- After pivot polishing, partial reassembly to inspect
- Look for hole wear
- Main wheel bushing wear
- Verge hole and faces
- Trundles

Hole wear

- Mark worn holes (DO NOT SCRATCH!)
  - Use ”Sharpie” style pens

Bushings

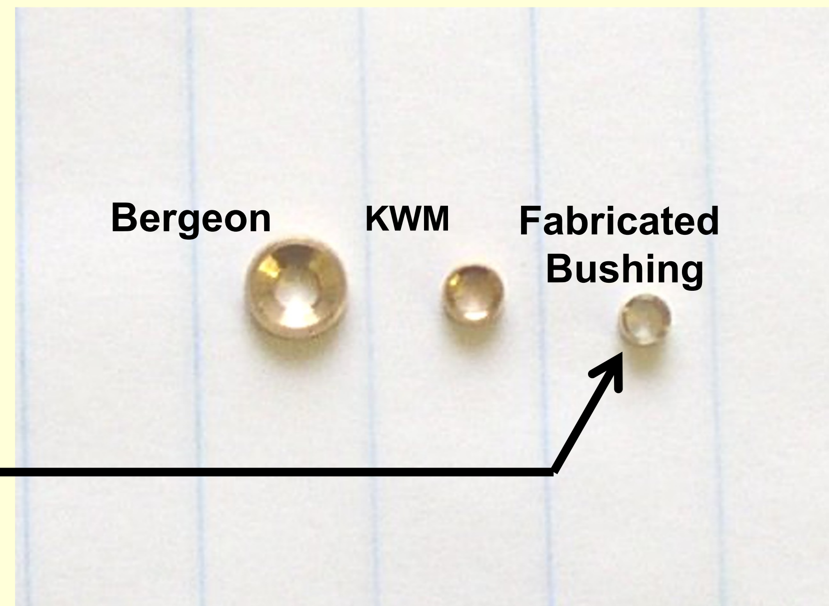
- Thin plates (often .050")
- Close clearances
  - Many holes close to plate edges
- Tough to bush with Bergeon
- Can break out of plate or leave thin walls
  - Recommend learning to make your own
    - If only for the stringent locations
  - If you are reluctant, then ONLY use KWM

Bushings--Considerations

- I sold my K&D Bushing tool 25 years ago
  - Tool was sloppy and inaccurate
  - Haven't found one any better (including Bergeon)
  - About the same cost as a lathe (actually, more!)
    - You need the lathe to polish pivots anyhow!
- Reamers are poor quality
  - Too small, too large (bushings loose), dull
  - Throw up burrs that are difficult to remove
  - Pushers, anvils rough and unfinished
- Bushing kits are hit and miss
  - Sizes inadequate for thin plates
  - On American clocks, can't always afford oil sinks
- Cost—if you want to consider it...
  - A 225-pc Bergeon kit is $103
  - <$5 of materials

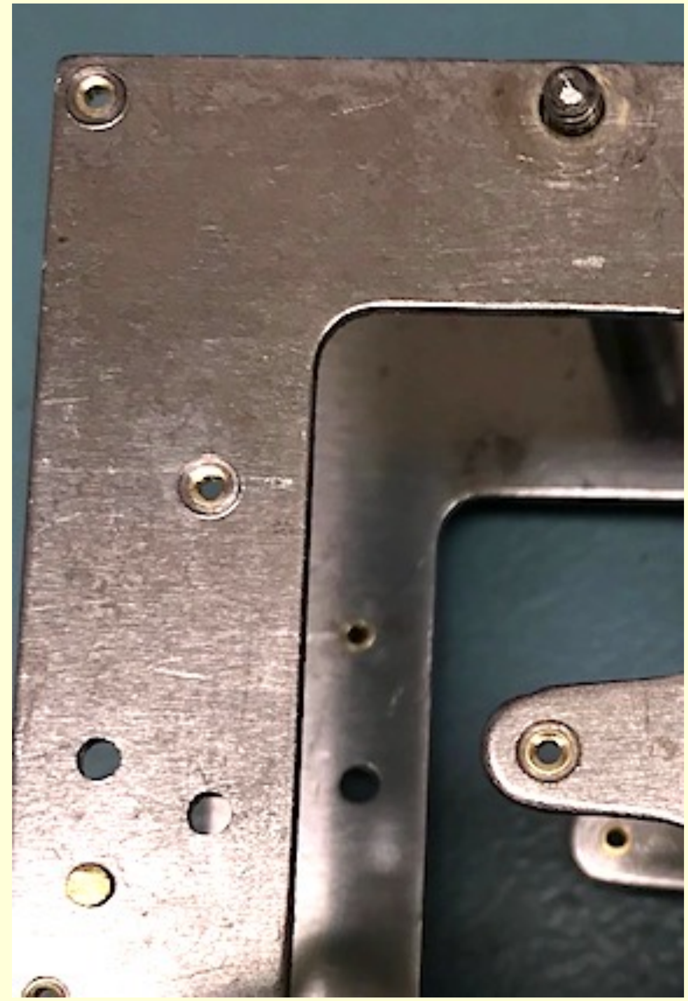
Fabricated Bushings

- Recommend fabricated bushings
  - Fabricate them as needed from 360 brass rod
  - Work very well at edges of plates
  - If not comfortable, then bore out smaller OD standard bushings
- If you use standard bushings, prefer KWM
  - OD's substantially smaller than Bergeon
- Keeps repair inside original oil sink
- Don't bush bushings
  - Just as easy to make a bushing
- At right:
  - equal hole diameter
  - OD = 1.5 x ID often plenty



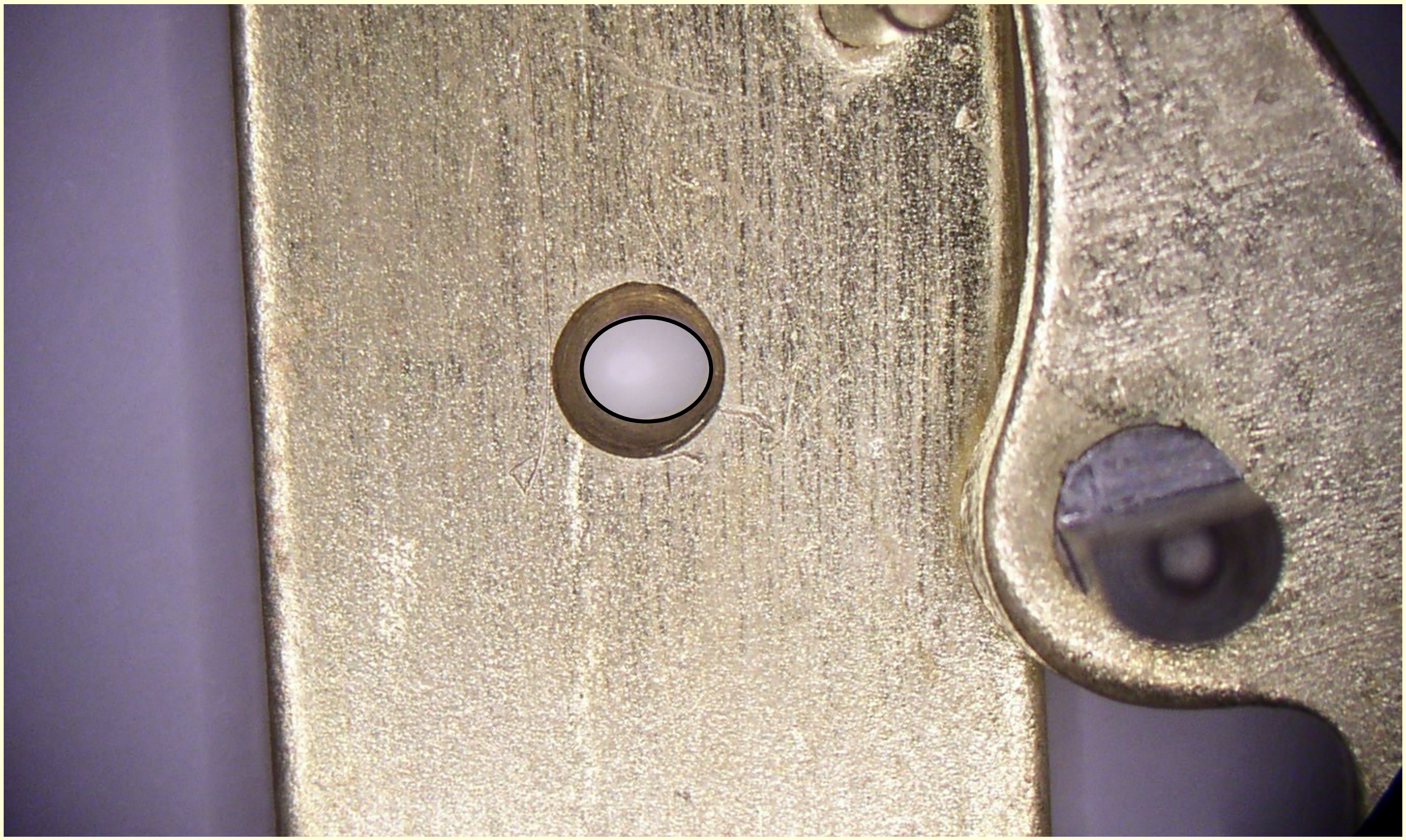
Why make your own?

- Accommodates well with American clock plates (holes near edges)
  - Minimally invasive
- Bushing is riveted/work hardened in place
- Can replicate original oil sink
  - Can choose no oil sink, or simple chamfer
- Centuries-old method; pre-dated box bushings
  - Just as efficient, fast (once learned)
- Eliminates loose and protruding bushings
- Can also modify box bushings in lathe to achieve above



Bushing Second Wheel Front Hole

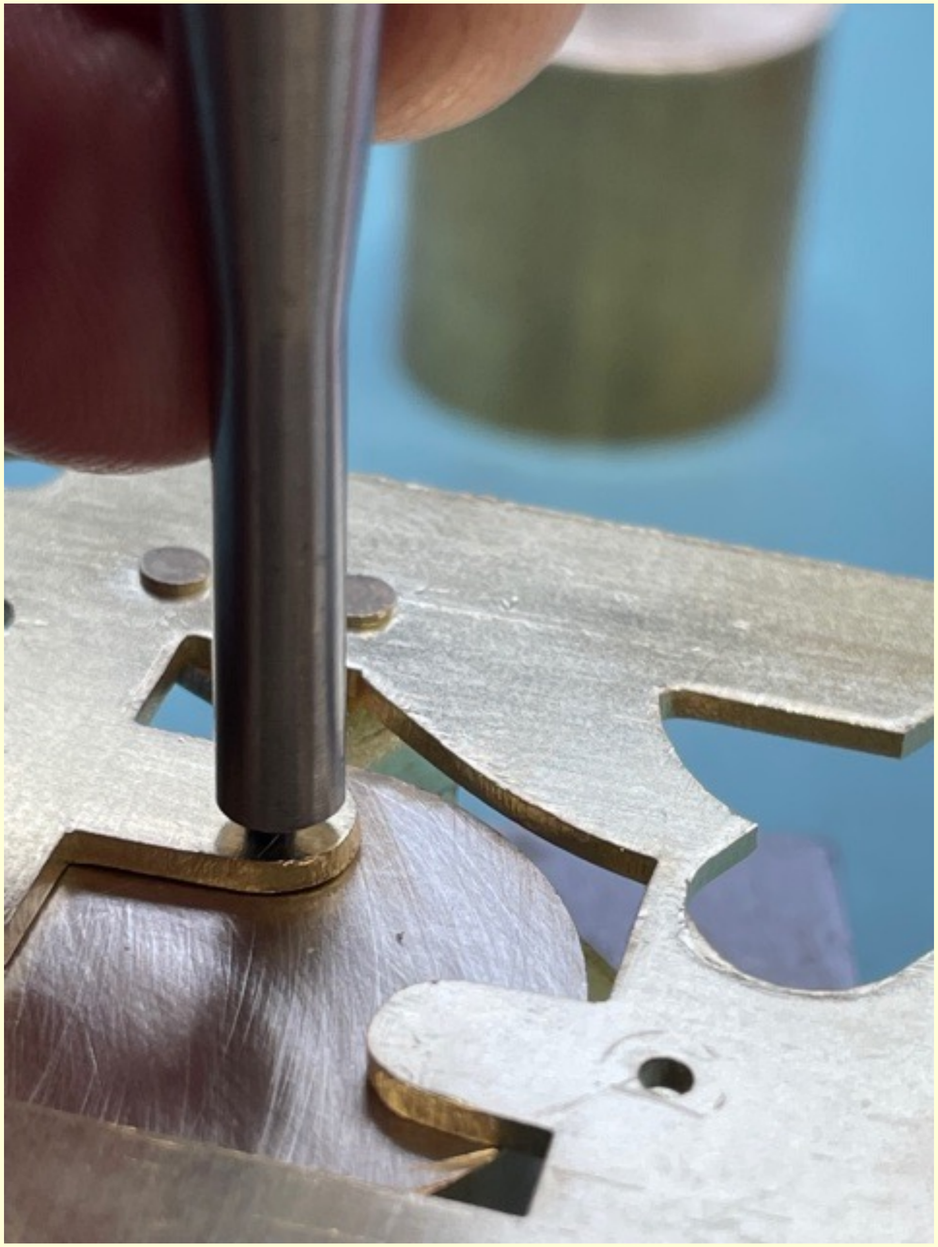
Close up shows oval wear evident



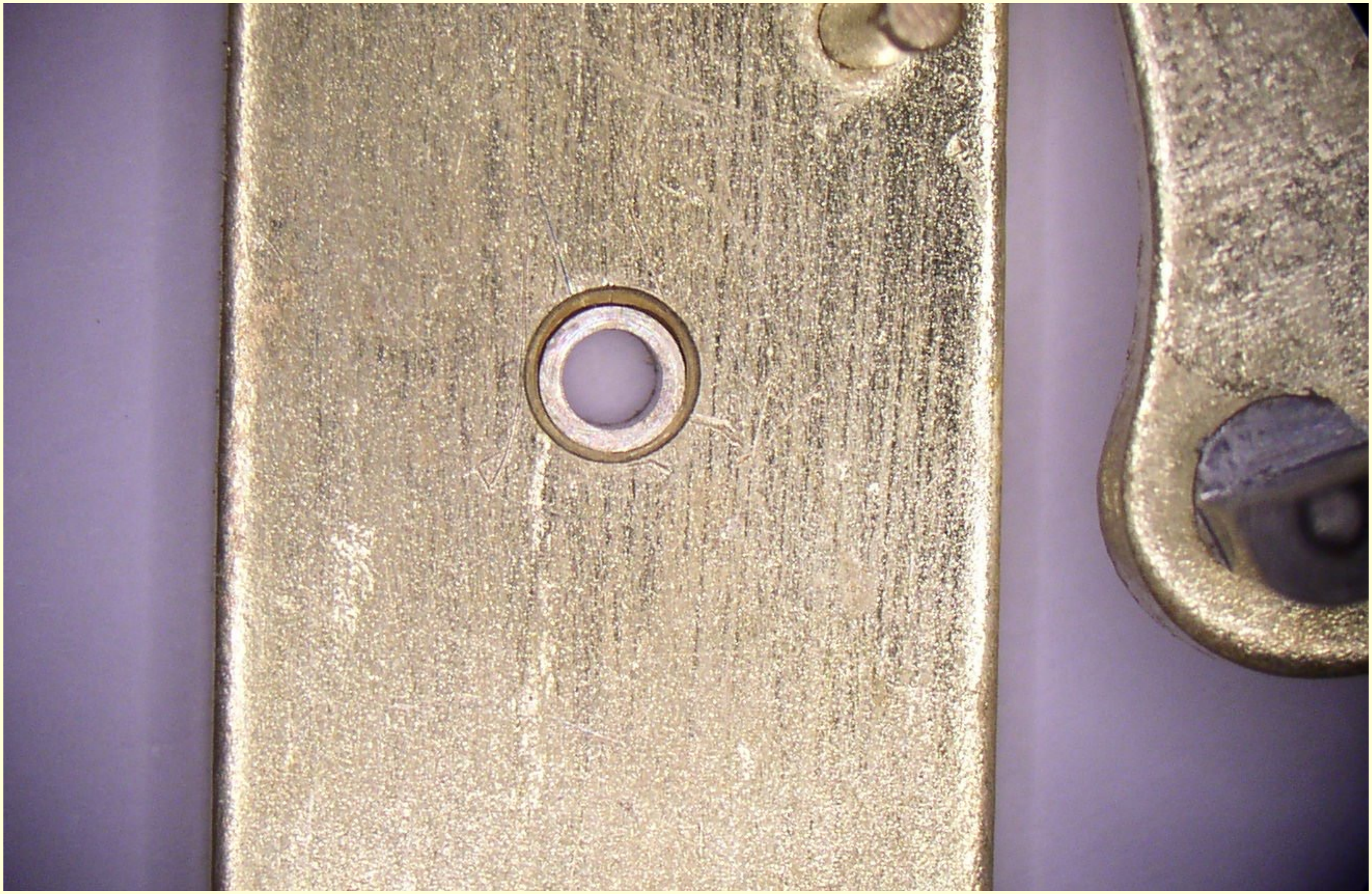
Hole Filed to Center and Broached

Turning up Bushing on Lathe

Installation



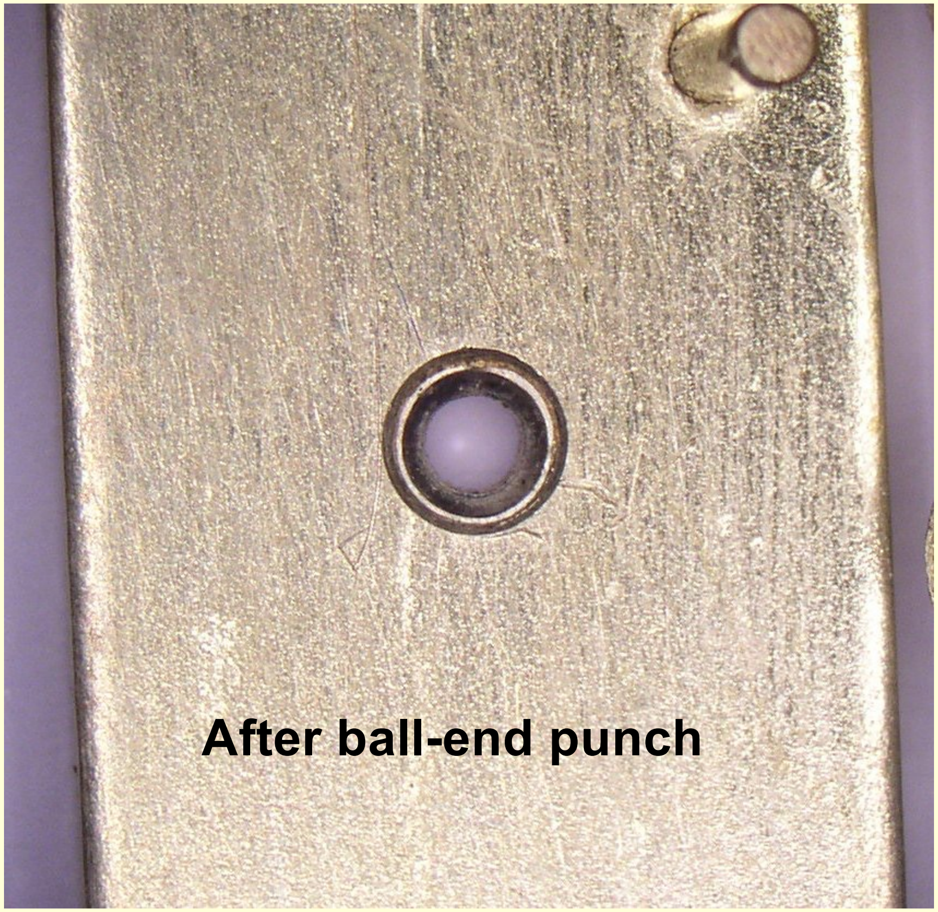
Front View of Installed Sleeve

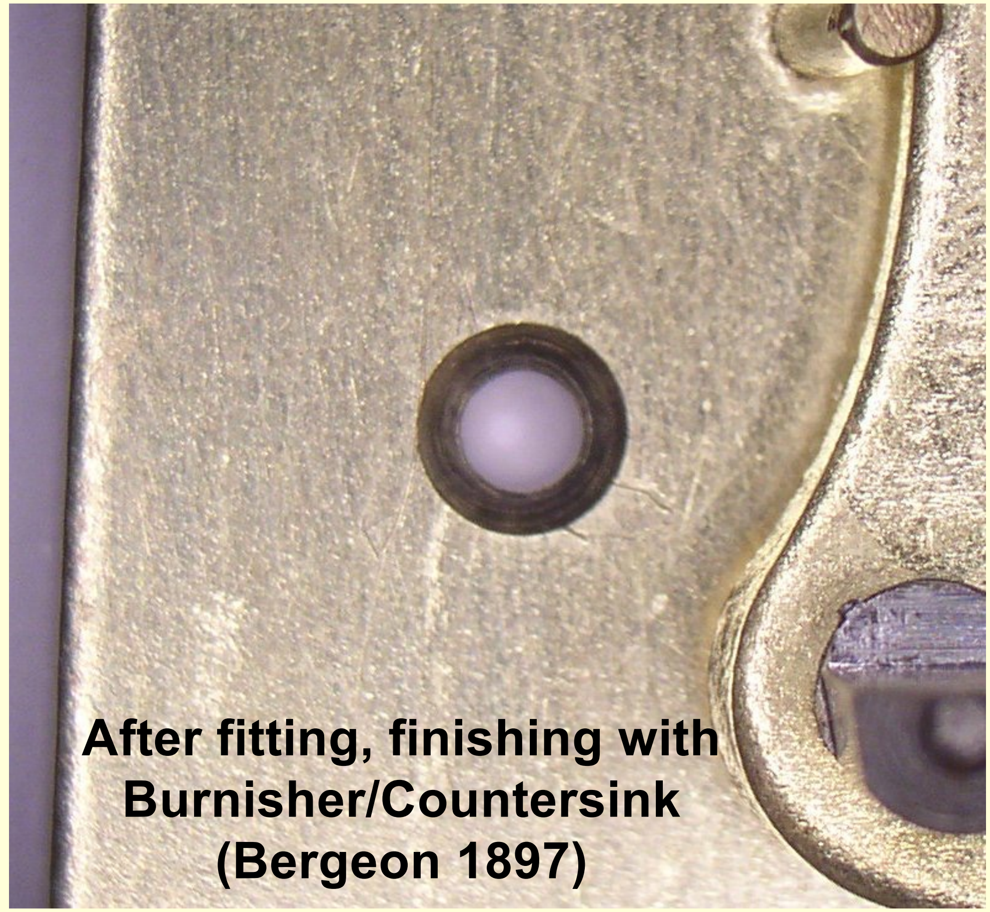


Shaping Oil Sink

Use ball end punch to shape oil sink

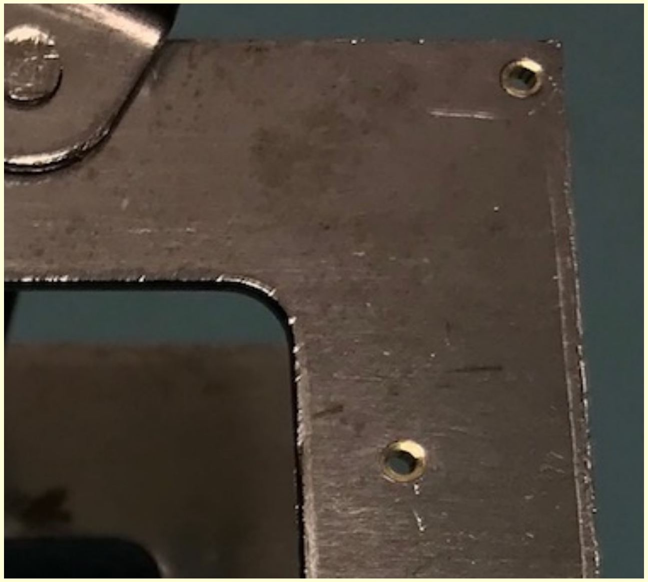
Finishing the Job





Another View of New Bushing

Bushing the Ingraham



Suspension Springs and Rods

- Almost 100% sure yours is a replacement
  - Be careful of sizes
  - Very little data on original sizes and styles
- Numerous styles were used
- Newer replacements are questionable quality
  - Sloppy assemblies
  - Incorrect dimensions
  - Cracked feathers, deformed rods, rust

Kevnatts (Amazon?) or Mile Hi

Timesavers, Ronell

Suspension Springs and Rods

Observations

- Generally, over 0.004” thick is problematic
  - Seen 0.005” on 20”+ rods with heavier bobs
- Many early springs were .003” x 0.25” x 1.375”
- Replacements often 0.004” x 0.1875” x 1.25”
- Feathers available all the way down to 0.002”
  - But are usually 0.1875” wide and 1.25” long
- Sometimes fabricating replacements is only way to get proper size

- **Note: Suppliers generally specify overall length**

Suspension Springs and Rods

Why not use a standard off the shelf replacement?

- If dimensions of suspension spring are wrong:
  - Movement may not run
  - Timekeeping WILL be affected
  - Pendulum may wobble

- Wobble is a serious issue

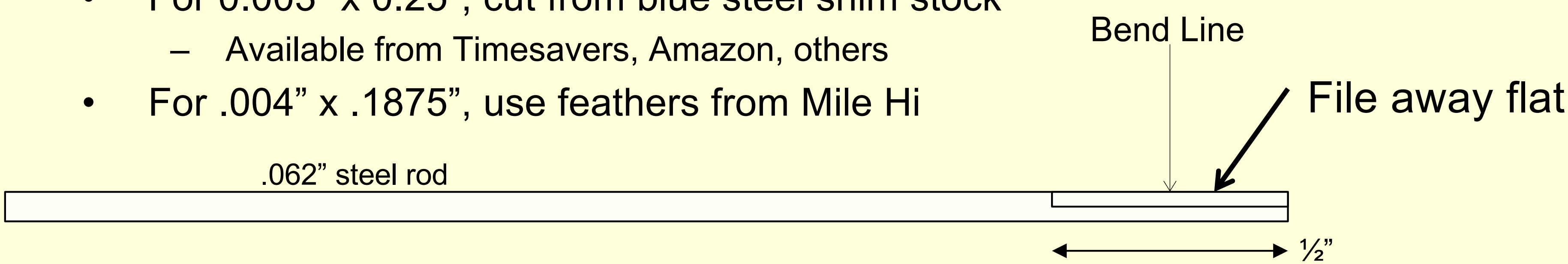
- For our subject Ingraham clock:
  - Left: 0.006” x 0.1875” x 1.25” **STOPPED CLOCK**
  - Right: 0.003” x 0.25” x 1.375”
  - Also tried .003” x 0.1875” x 1.25”; resulted in severe wobble

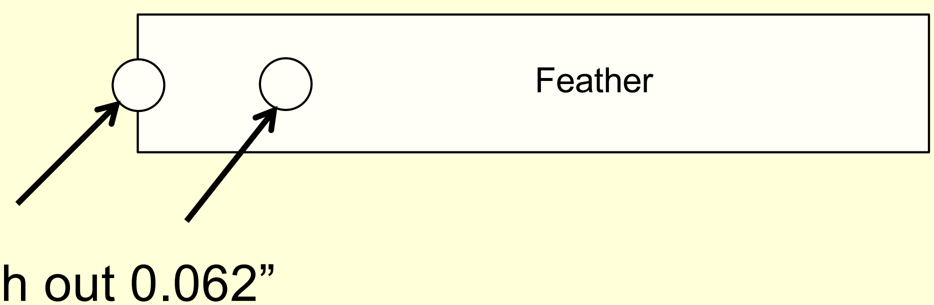
Wobble

- Wobble is rotational moment of pendulum interacting with suspension spring
  - Kills power
  - Erratic timekeeping
- Pendulum rotates
  - Motion reinforced by impulse beat
  - Resonates with suspension spring
- Check for wobble when changing suspension springs
  - Pendulum mass, sizes vary
  - Wider suspension springs can help
  - Sometimes thinner or thicker spring can help

Fabricating Replacements

- Start with 1/16" mild steel rod
  - Airgas or Eastwood mild steel welding rod, uncoated
  - 4140 alloy 1/16" rod from McMaster Carr
  - Don't use drill rod—will not take bending well
  - Save cutoffs from suspension rods
- File flat on ½" of width to 0.030" or less
  - Speed up by carefully grinding with Dremel
- For 0.003" x 0.25", cut from blue steel shim stock
  - Available from Timesavers, Amazon, others
- For .004" x .1875", use feathers from Mile Hi





Summary and Guidelines

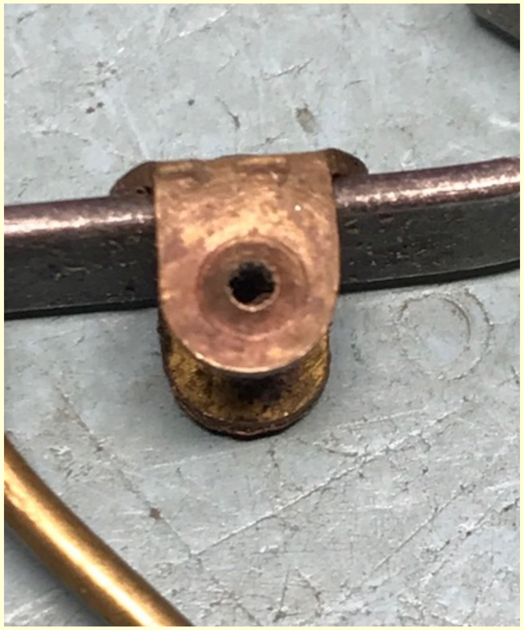
American Clock Suspension Rods

- 0.003” or 0.004” thick replacements only
  - Avoid rolled flat style (thickness wrong)
- If missing, start with 0.003” x 0.25” x 1.375”
  - Ansonia Mantle: 0.004” x 0.1875” x 1.25”
  - Gilbert: 0.003” x 0.25” x 1.375”
  - Ingraham: 0.003” x 0.25” x 1.375”
  - New Haven T/S: .004” x .187” x 1”

- Supplier replacements unsightly but fine, if they work
  - Check wobble
  - Check quality
  - Check dimensions

The Trouble with Verges

- Often, faces are severely worn
  - Sometimes can be polished out
  - Some folks like to move escape wheel
    - Not always possible
- Saddle hole frequently worn
  - Often an oversize pin can be fitted
- Crutch wire sometimes loose
- Verge may be missing
- Why not just replace them?
  - There is a problem



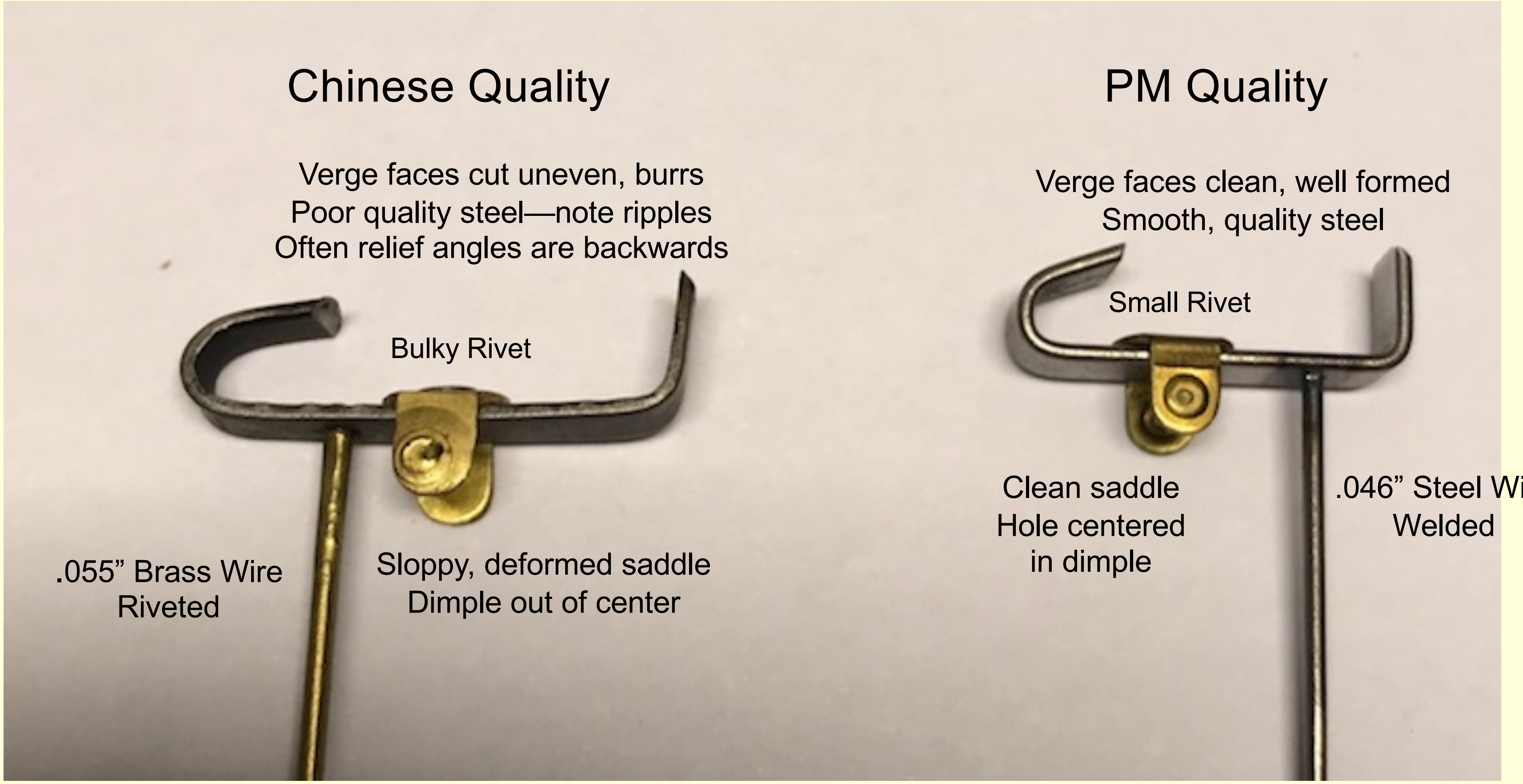
The Trouble with Verges

The Problem

- Great number of poorly made verges available
  - Misaligned saddles
  - Ill fitting wires
  - Verge faces poorly formed, unpolished/misaligned, burrs
  - Relief angles ground on wrong face
    - Or ground unevenly
  - Grossly large saddle rivets
  - Don't fit any clock
- Resorted to making them in some cases
- PM Clock Supply once offered excellent verges
  - Timesavers seems to have bought out stock
  - Mixes them with cheap Chinese parts in kits

Anatomy of a Verge

American Clocks



Verges

A Strategy

- Often an incorrect replacement is installed
- Procure the 9-pc or 12-pc assortment as a reference (they are inexpensive)
  - Find one that fits and works best
  - If PM quality, then polish and you're done
  - Otherwise, copy it (if you can)
  - Can use 0.032" precision ground O-1
- If original available, salvage it
  - For worn saddles, fit oversize pin

Fitting Oversize Verge Pin

- Example: Original was .052” (and distressed!)
- Replaced with .056” pin—huge improvement!



Worn Wheels and Trundles

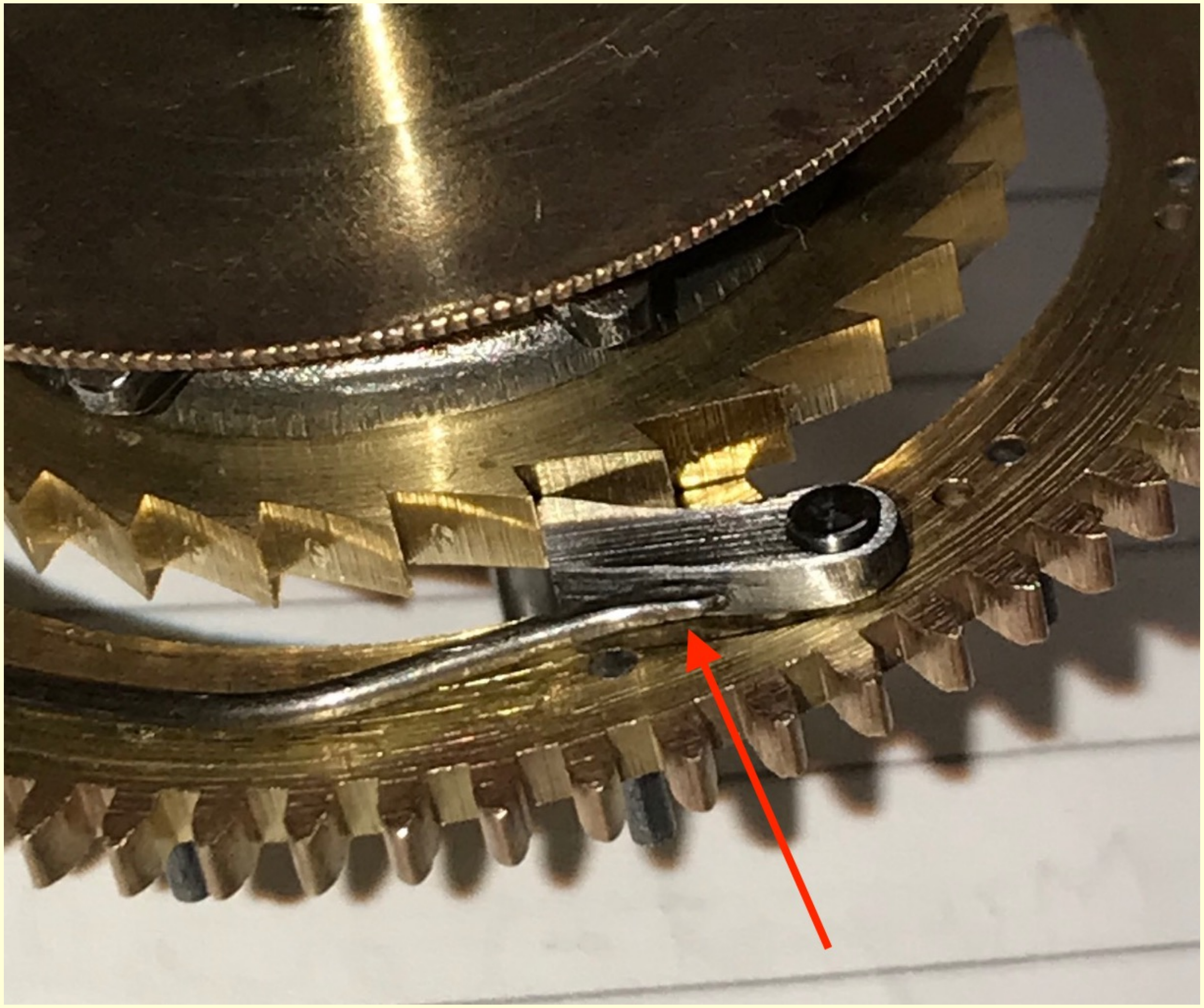
- Combine:
  - Long run time (over a century)
  - Over-powering mainsprings
  - Thin wheels, soft steel pinions
  - Oiling trundles or gears
- Trundle replacement often necessary
  - Failure = severe wheel teeth damage
- Main wheel teeth commonly wear or deform

Worn and Deformed Main Wheels

- In 70's, ¾" x 0.018" x 96" spring was popular as standard replacement for American clocks
  - Ended up in many clocks
  - Main wheels are only .050" thick
  - Result: Now, worn main wheels are common

- Fabricating and fitting replacements is a pain
  - Timesavers 11507 2.813" OD 84T fits:
    - Gilbert
    - Ingraham
    - Sessions
  - Does NOT fit:
    - Ansonia
    - New Haven

Worn Clicks



Clean up bulging clicks

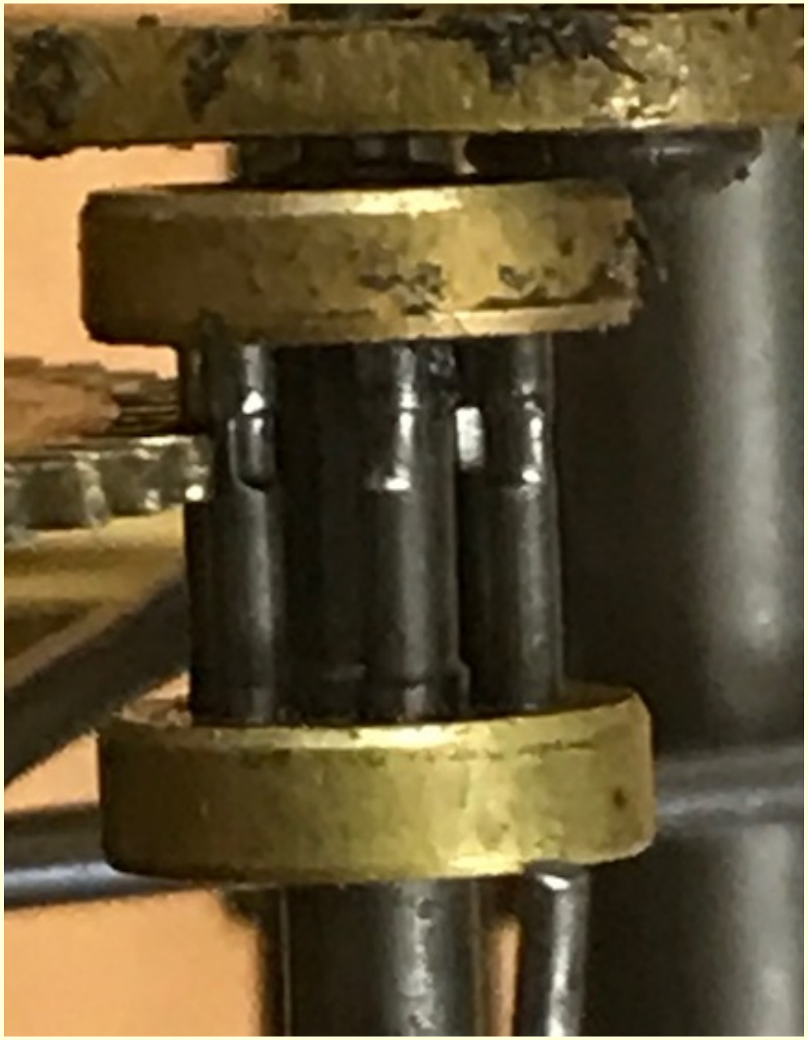
Re-shape worn clicks

Beware of spring slots

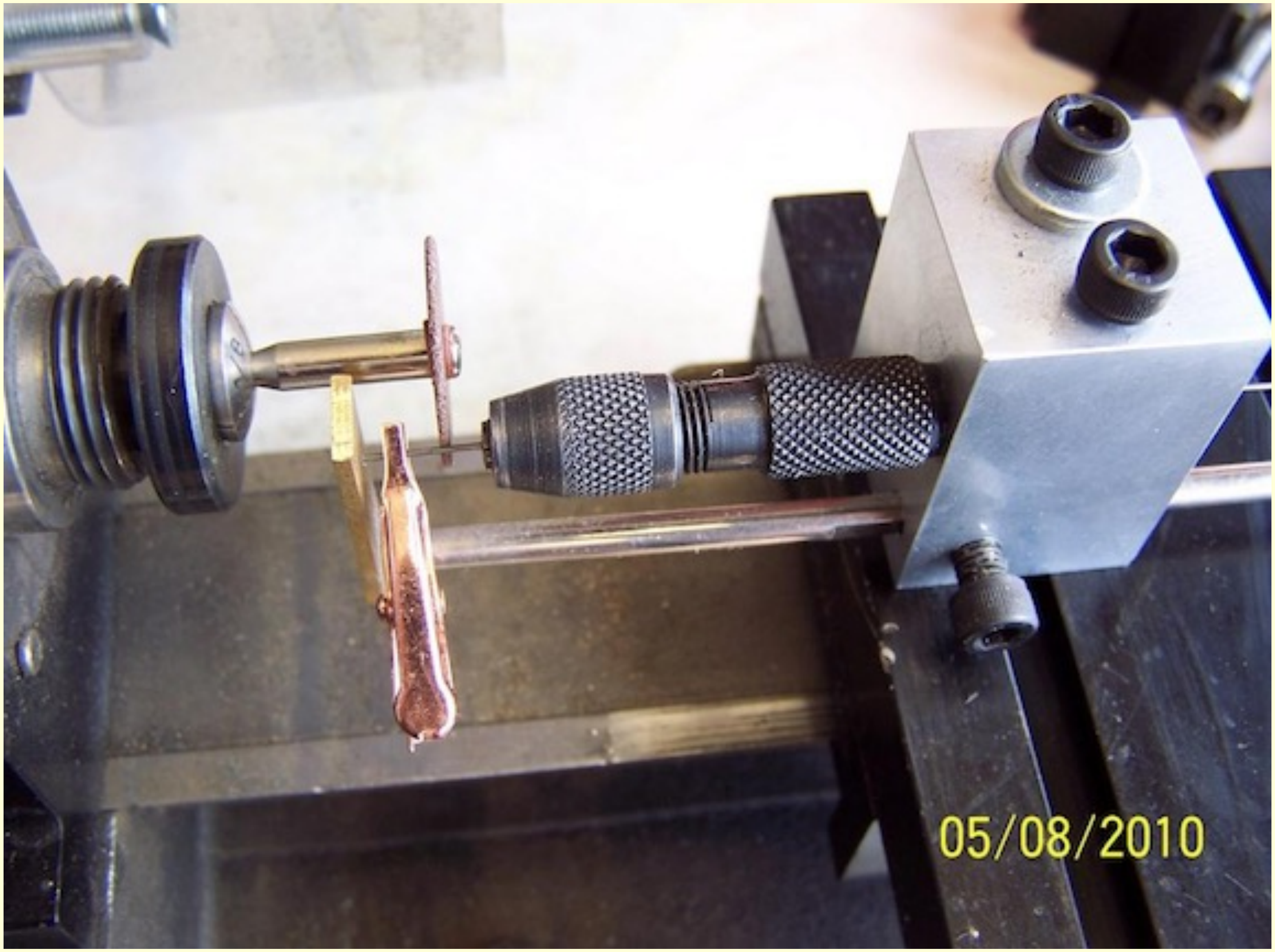
Replace rivets (steel!)

Worn Trundles

- Ruts in trundles promote further wear
- Trundles should be replaced if ruts are noticeable or deep
- Much documentation on how to repair these already exists
- Suggestions:
  - WorkSharp makes quick work of trimming and flatting trundle ends
  - Buy or make a tool for measuring and replicating (next slides)
  - Nearly every size available from Timesavers; search Pinion Wire



Tool for Making Trundles



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Tool for Making Trundles

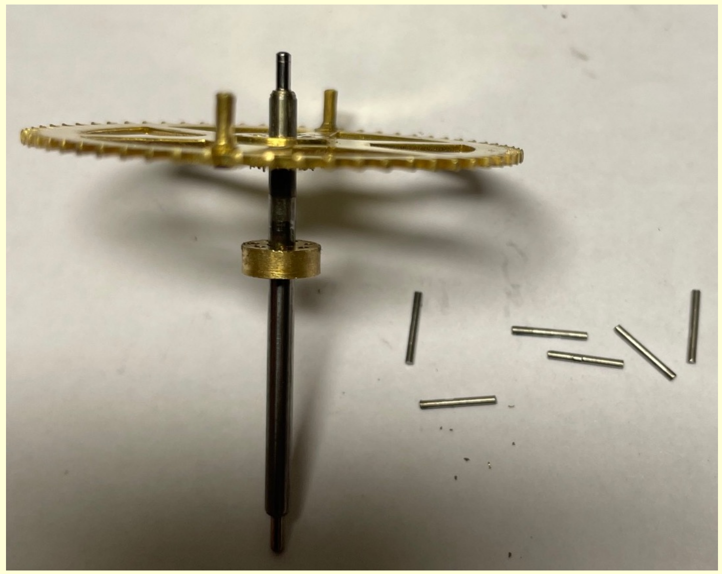
- Can be as simple as 12L14 rod
  - 3-4” length, 0.25” OD
  - End drilled to 10% over OD of wire stock
  - Fit wire in, cut off, and grind to surface of rod’s end
  - One rod = two different sizes
  - Tool can also be used to reinstall lift or verge pins

Trundle Repair

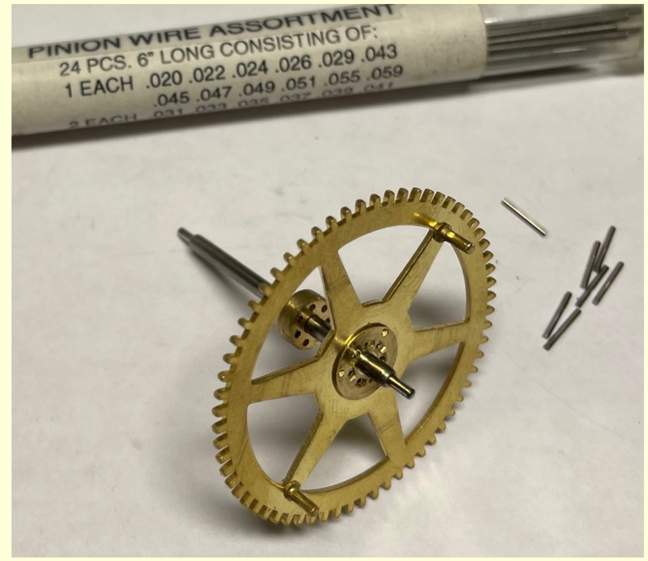
My Approach

1” brass cutoff
Drilled to accommodate
Trundle cage

.187” brass rod
Drilled to accommodate pivot
Acts as hollow punch



Drive up wheel/upper trundle shroud
Remove trundle pins



Select wire and cut to size

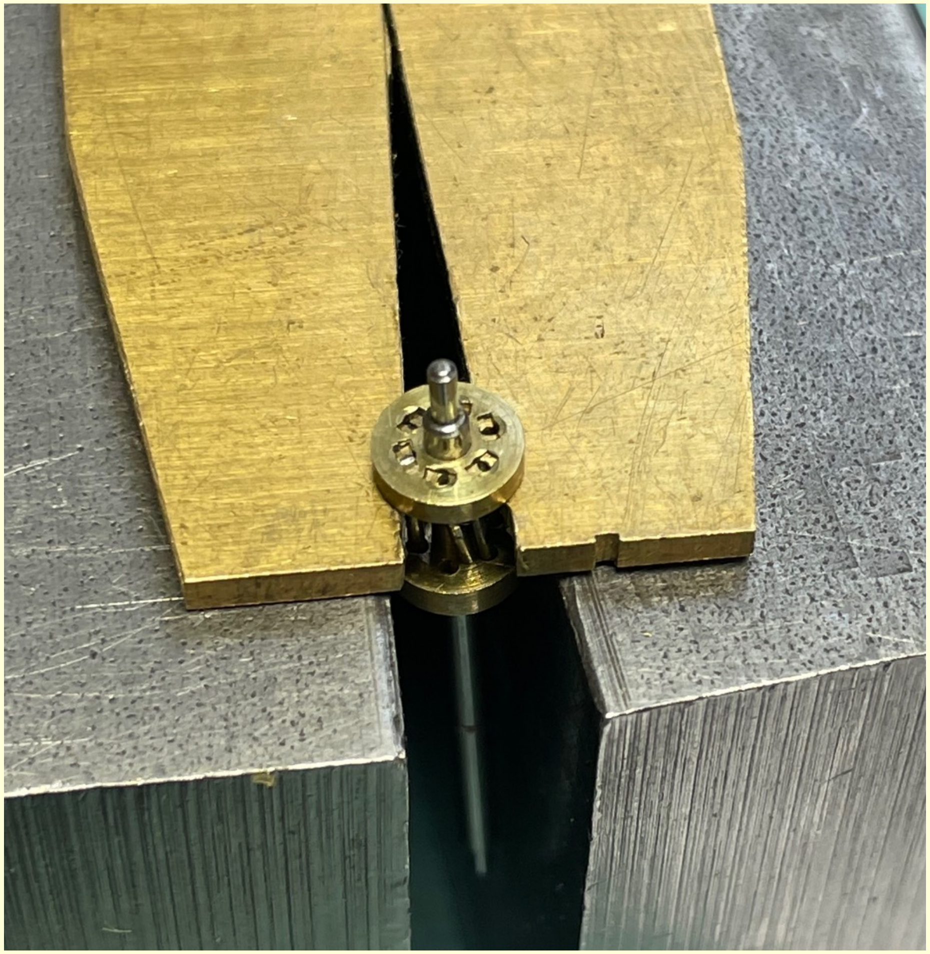
Reassembly is reverse of disassembly

Carefully work pins into holes; oil sometimes helps hold them

Shop-made “Split” Stake

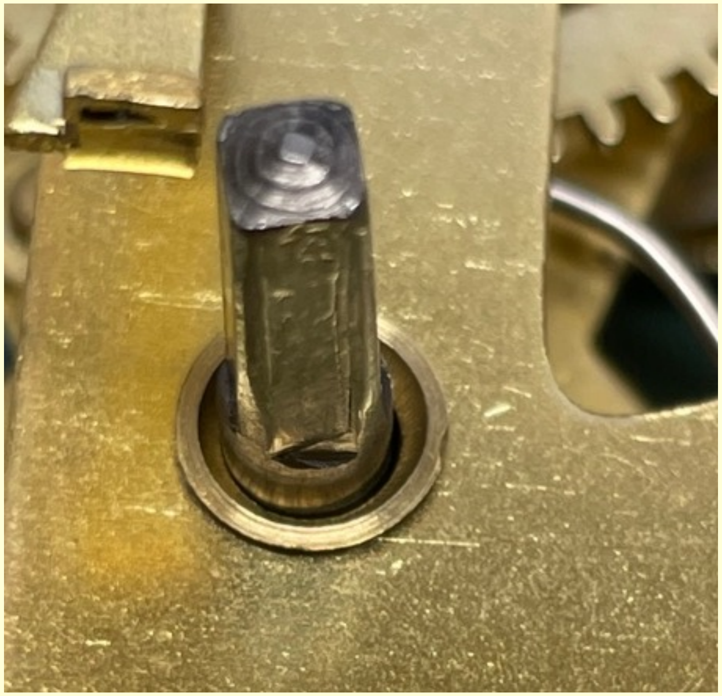
Simple tool to support lanterns while opening

- Commercial split stakes often too thick for lantern pinions
  - Or, they are steel and mar shrouds
- With .062” brass stock you can make this simple tool
  - Cut vee with jewelers saw or similar
- Mount it on two same-size blocks or a vise
  - Or, lay on top of split stake to clear wheel as case may be
- Does job without marring shrouds



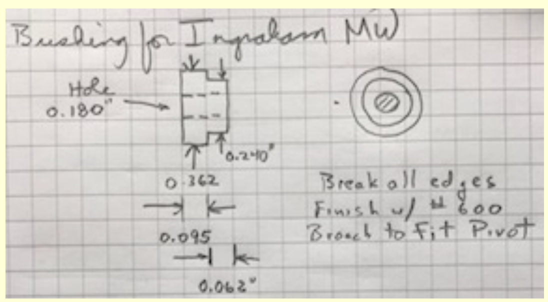
Main Wheel Bushing Wear

- Look for excessive wear AND tunneling
  - Nearly always present; sometimes extreme
  - Incorrect mainsprings (too strong) accelerates problems



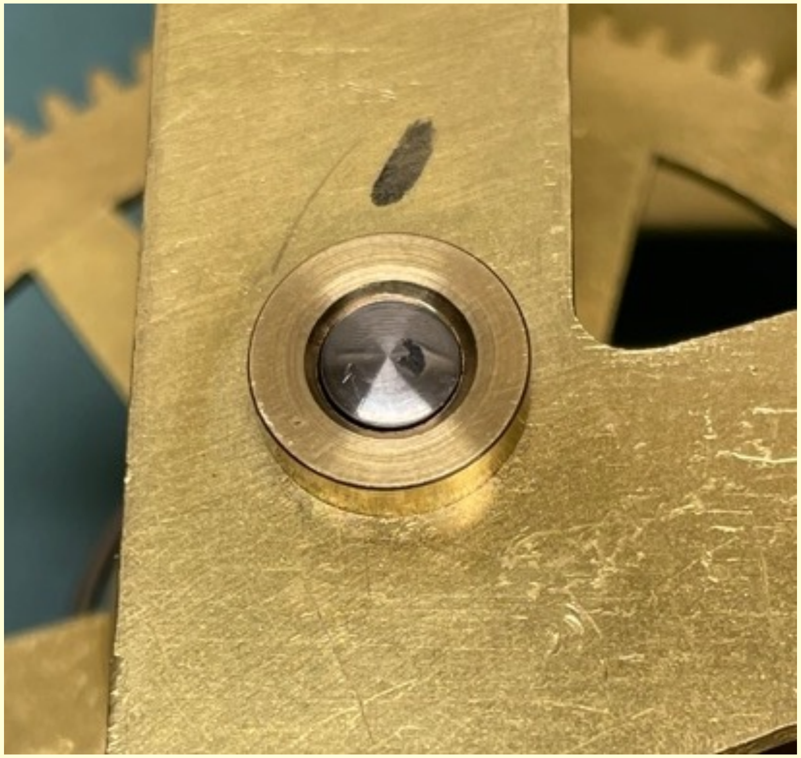
Main Wheel Bushings

- Most neglected, overlooked area—Don't!
- Can cause many problems
  - Accelerated main wheel wear
  - Second wheel trundle wear
  - Interferences resulting in stopped clock
  - Catastrophic failure
- Easy to repair
  - Knock out
  - Turn on lathe
  - Rivet back in
  - Broach to size
- We've covered all steps in our workshops



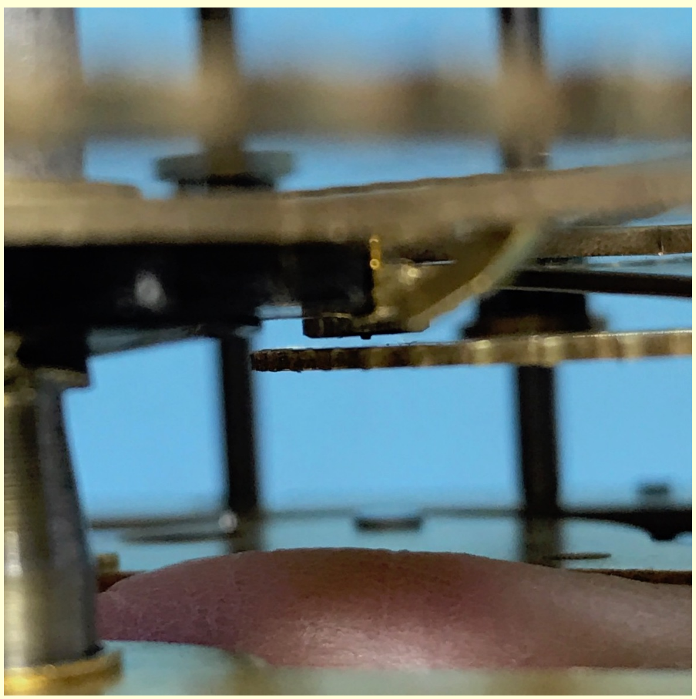
Main Wheel Bushings

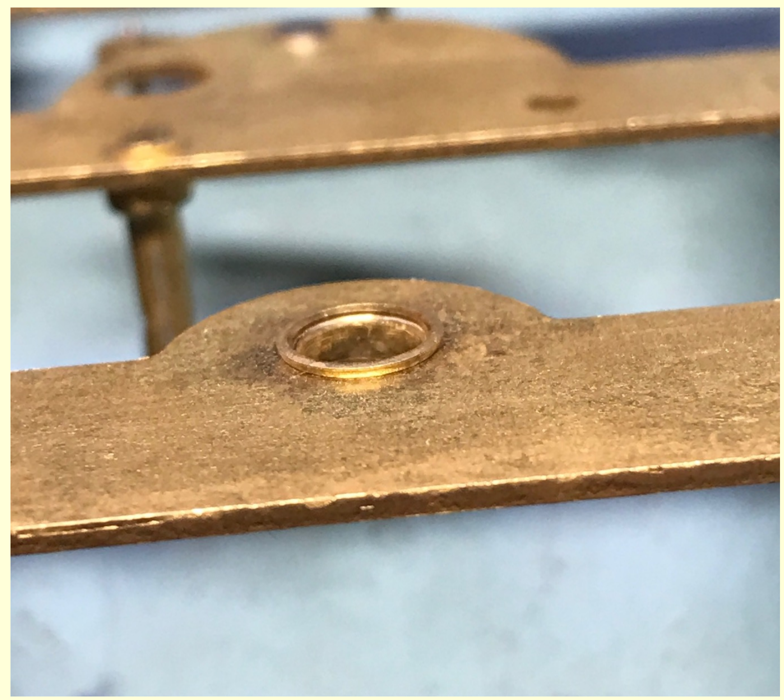
After restoration



Elusive Main Wheel Bushing Issue

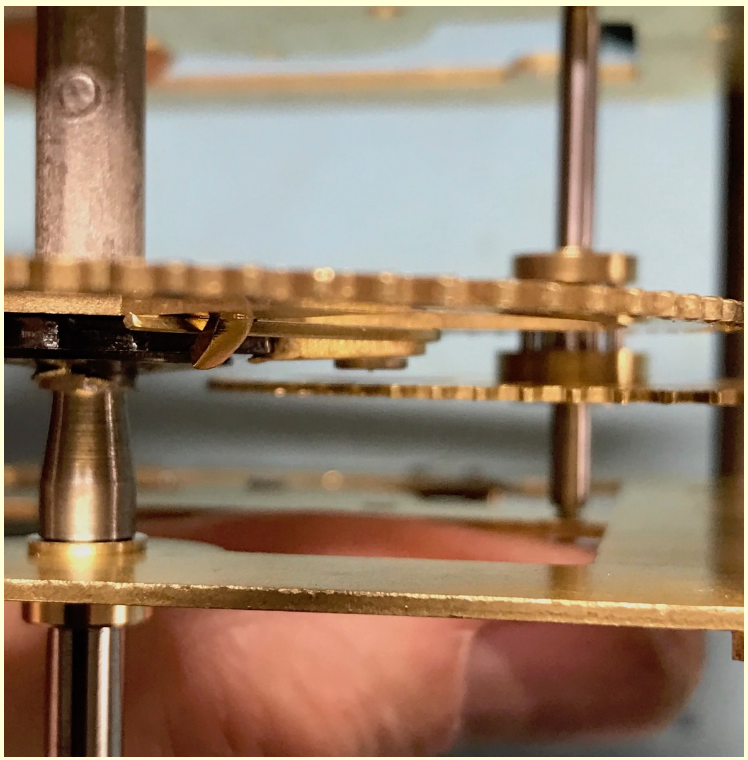
- Carefully inspect MW bushings
  - American clocks
- Wear patterns can be elusive
  - Source of surprise interferences

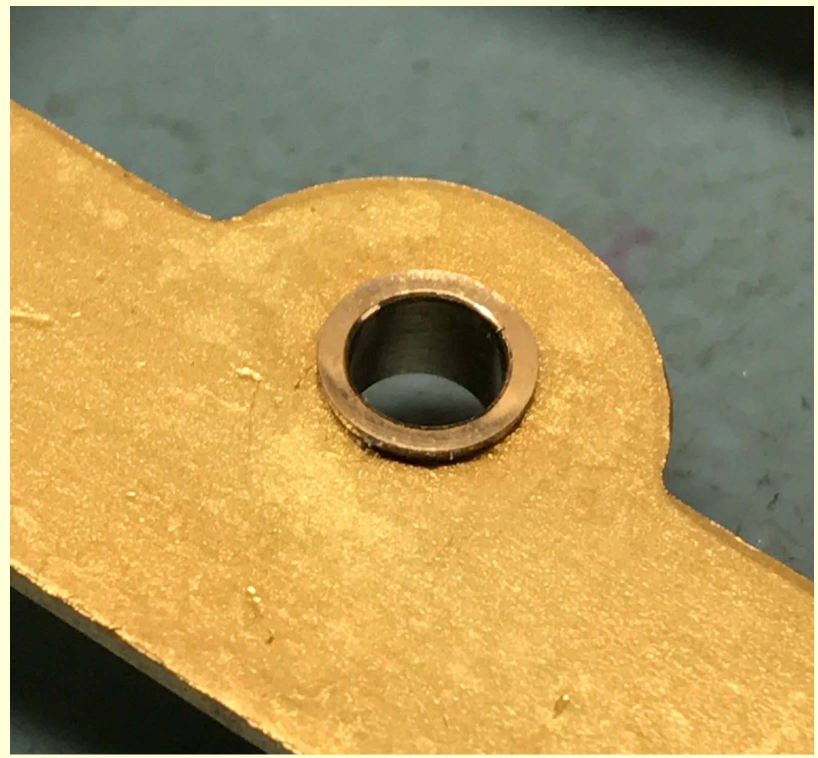




Main Wheel Bushings

- A new bushing cures problem!

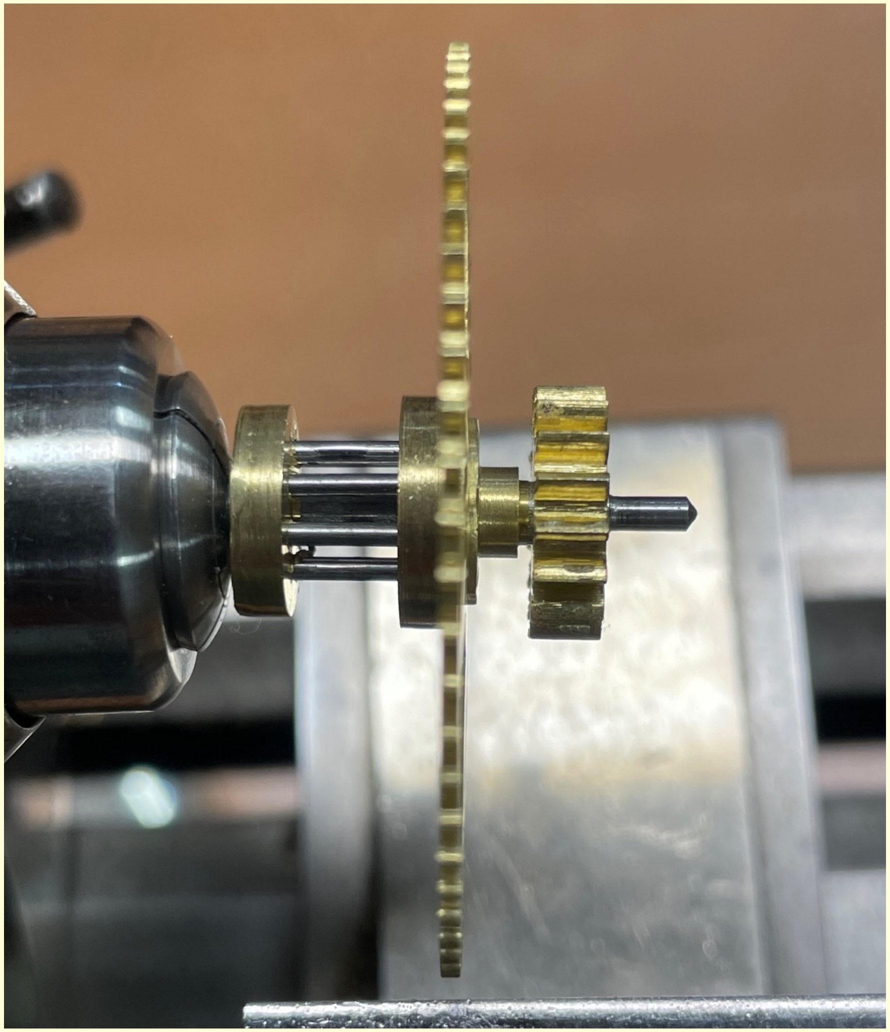




Broken Mainsprings

Collateral Damage

- ALWAYS collateral damage
- Look for bent 2nd wheel arbors
- Look for bent 2nd wheel trundle wires
- Straighten arbor with fingers if possible
  - Don’t push on wheel



Mainsprings

ALWAYS evaluate and analyze

- ¾” x .018” x 96” mainsprings: Avoid
  - Exceptions: Sessions 2-train Westminster chime, ST #42
  - Strength goes as T^3 e.g., $(.018/.0165)^3$ = 30% stronger
- Consider **maximum** strength ¾” x .0165” x 96”
  - Many original springs specified .017” by manufacturer
  - Newer spring steel stronger than original alloys
- Successfully used .015” thick springs
- German-made springs preferred (Mile Hi, Timesavers)
- India springs last resort (distorted centers, sloppy loops)

- ***Spring width is important too!***

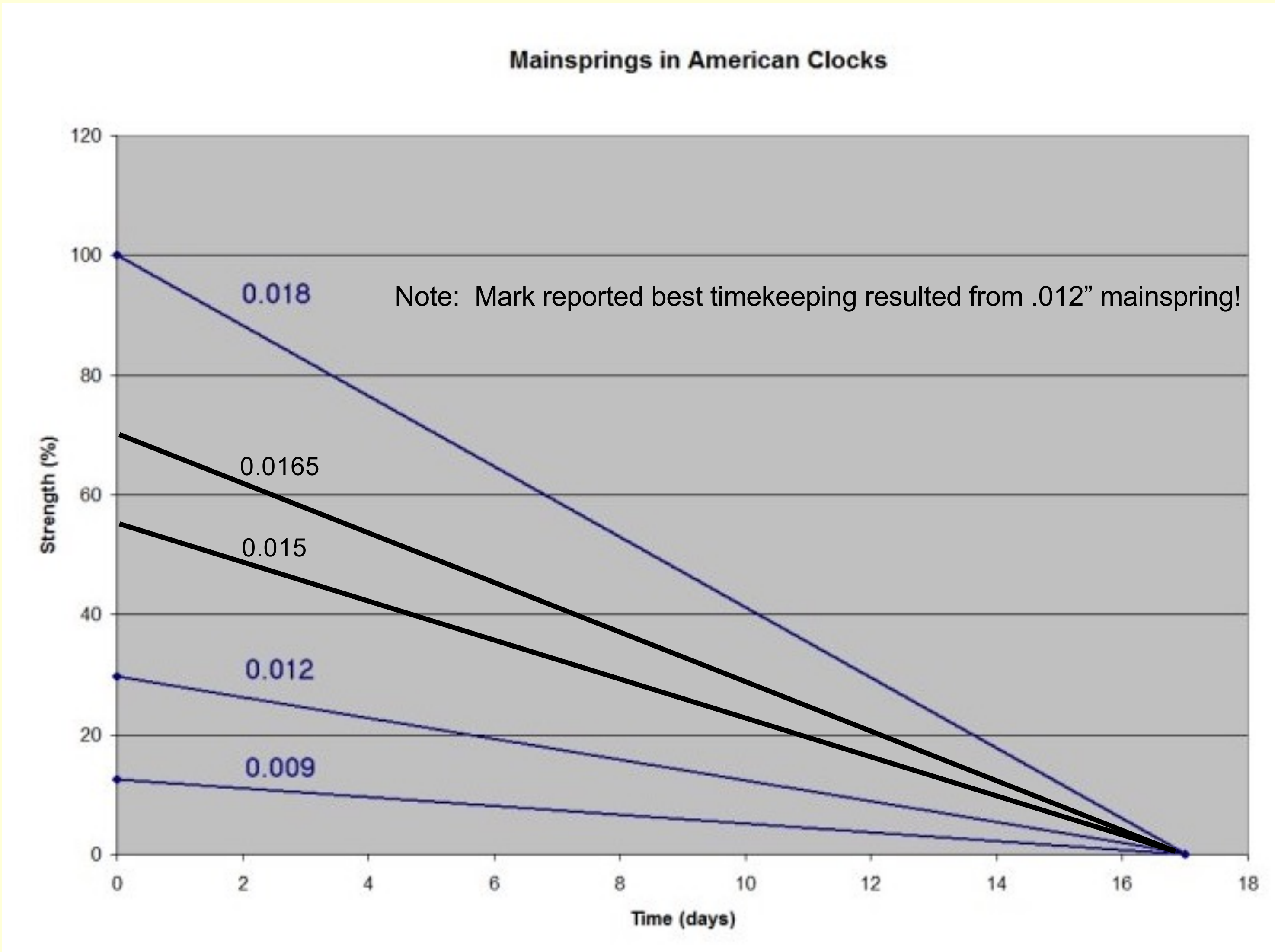
- Do NOT use a ¾” spring if 11/16” was original
  - Will eat away at main wheel over time (see right)
  - Consult Tran duy Ly books: sizes sometimes published
  - **When in doubt, use a size smaller/thinner than original**

Table of Mainsprings

Common American (loop-end) Movements

Movement	OEM Recommended	Closest Replacement
Seth Thomas 89 T/S	¾" x .017" x 108"	¾" x .016" x108" Timesavers 29515
Seth Thomas 44	11/16" x .015" x 108" (Some versions specify .018")	11/16" x .015" x 108" Mile Hi #CML175.1 (German)
Seth Thomas 42 (Lyre)	¾" x .020" x 72"	¾" x .0177"x 96" (cut to length if needed) Timesavers 32928 (German)
Ingraham 8-Day Pendulum	¾" x .017" x 96"	¾" x .0165" x 96" Timesavers 32927 (German)
Ansonia 9 ¼ and similar	Time: 5/8" x .014" x 120" (Conover) Strike: ¾" x .014" x 120" (Conover)	Time: 5/8" x .013" x 105" (HE) Timesavers 16802 (add loop) Strike: ¾" x .014" x 108" Timesavers 16880 (German)
Gilbert	¾" x .0165" x 96" (Conover Recommendation)	¾" x .0165" x 96" Timesavers 32927 (German)
New Haven 303-337 style	¾" x .015" x 126" (Conover) Note: Too tight in plates!!	11/16" x .015" x 108" Mile Hi #CML175.1 (German) Timesavers 17525 (German) Timesavers 33529 .014" option
Sessions (Time, Strike, 2-train Chime)	¾" x .017" x 96" Chime: ¾" x .018" x 108"	¾" x .0165" x 96" Timesavers 32927 (German) ¾" x .018" x 96" Chime side Alternate chime: ¾" x .017" x 120" Timesavers 15959

Mainspring Strength vs. Timekeeping



Adapted from Mark Headrick’s Abbey Clocks http://www.abbeyclock.com/mainsprings.html

Proper Mainspring Hygiene

Be careful!

- ALWAYS clean springs! Even replacements
- Use a mainspring winder
  - NEVER try to wind in by hand
- ALWAYS use glove to keep spring in control

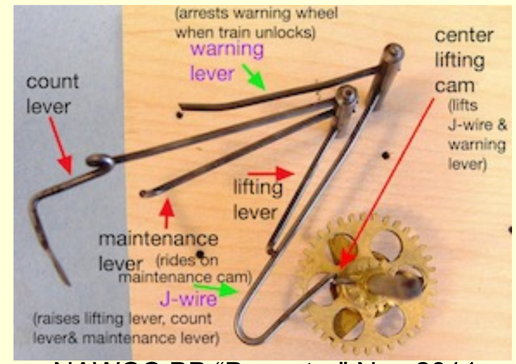
Keystone winder (Mile Hi)

Mainspring Winders

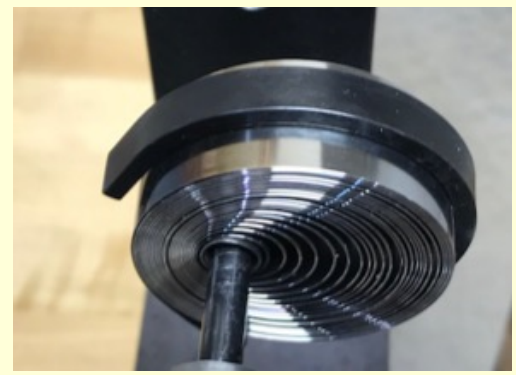
- **Webster:** Sold mine (robustness of chuck) ☹
  - Hook and loop supports not adjustable ☹ ☹
- **Keystone:** Been using almost 20 years
  - Rigid; chuck, barrels substantial ☺
  - *Hook and loop supports adjustable!* ☺ ☺
  - No ratchet ☹
  - Sliding winding arbor sometimes difficult 😐
  - Rear arbor support less useful 😐
- **Ollie Baker:** Looks great; never used
  - Looks substantial; winding arbor rigid ☺
  - I like the ratchet ☺
  - Uses let down chucks for arbor, included (less marring) ☺
  - Hook and loop supports NOT adjustable ☹ ☹
- **Accu Winder** (Ronell)
  - Looks like Ollie Baker knock-off
  - Does not include let down chucks ☹

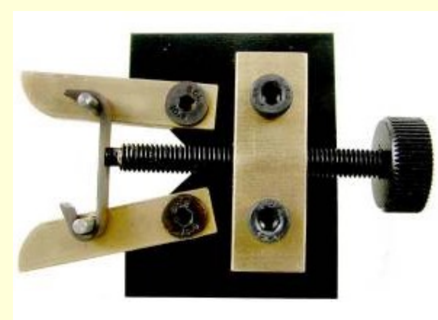
Miscellaneous Tips

- Drop/Count Lever Springs:
  - Use .012”-.014” spring brass
  - Any more will require more power
- Use flat style MS clamps
  - Easier to remove after servicing
  - Mile Hi stocks them
- Consider verge adjuster tool
  - Allows minute bends
  - Without it is risky trial and error

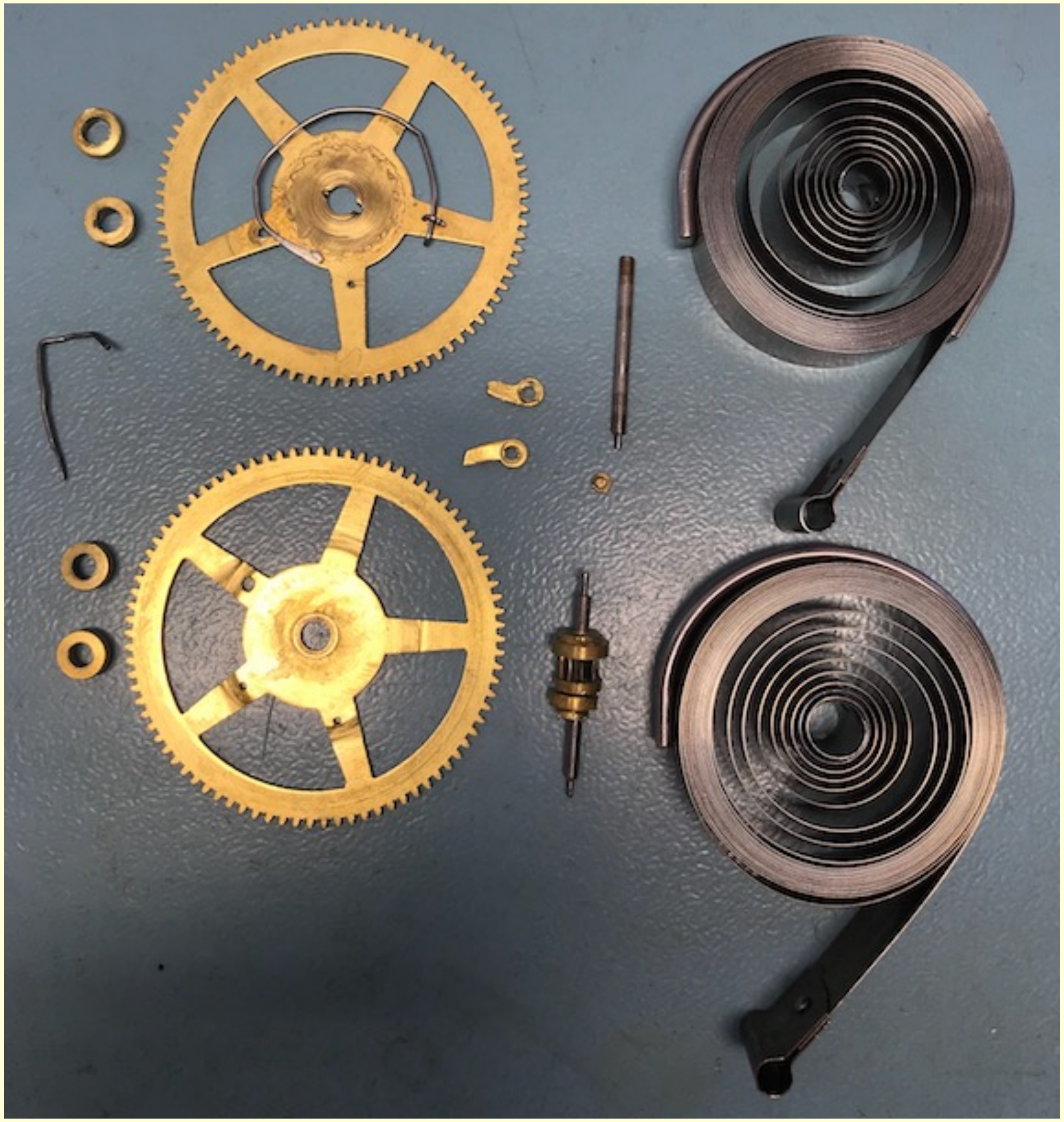


NAWCC BB “Bangster” Nov 2011





Our Subject Clock: Parts Replaced



(4) MW Bushings
(18) Plate Bushings (trains)
(2) Clicks (destroyed)
(2) Click Rivets
(2) Click Wires
(2) Main Wheels—pitted, teeth worn
(1) T 3rd Wheel Arbor (poor re-pivot)
(1) Mainsprings ¾” x .018” x 96”
(1) Arbor/Pinion Assembly (destroyed)
(1) Verge Retainer wire
(1) Suspension Rod

Useful References

- Calculating Mainspring Length in Barrel:
  - NAWCC now has an online calculator
  - http://www.nawcc-index.net/CalcMainspringLength.php
  - Basically, it's 1/(2T) x (inside area of barrel-area of arbor) where T is the mainspring thickness (and error on too long vs. too short).
- Steven Conover: *How to Repair 20 American Clocks*
  - https://www.clockmakersnewsletter.com/store/c1/Featured_Products.html
- Steven Conover: *Clock Repair Basics* (same links as above)
- Steven Conover: *Chime Clock Repair* (same links as above)
- Steven Conover: *Building an American Clock Movement* (same links as above)
- Donald deCarle, FBHI: *Practical Clock Repairing.*
  - Covers proper gearing, determining required beat, making parts, alternate bushing methods, pivot polishing….

Thank you!