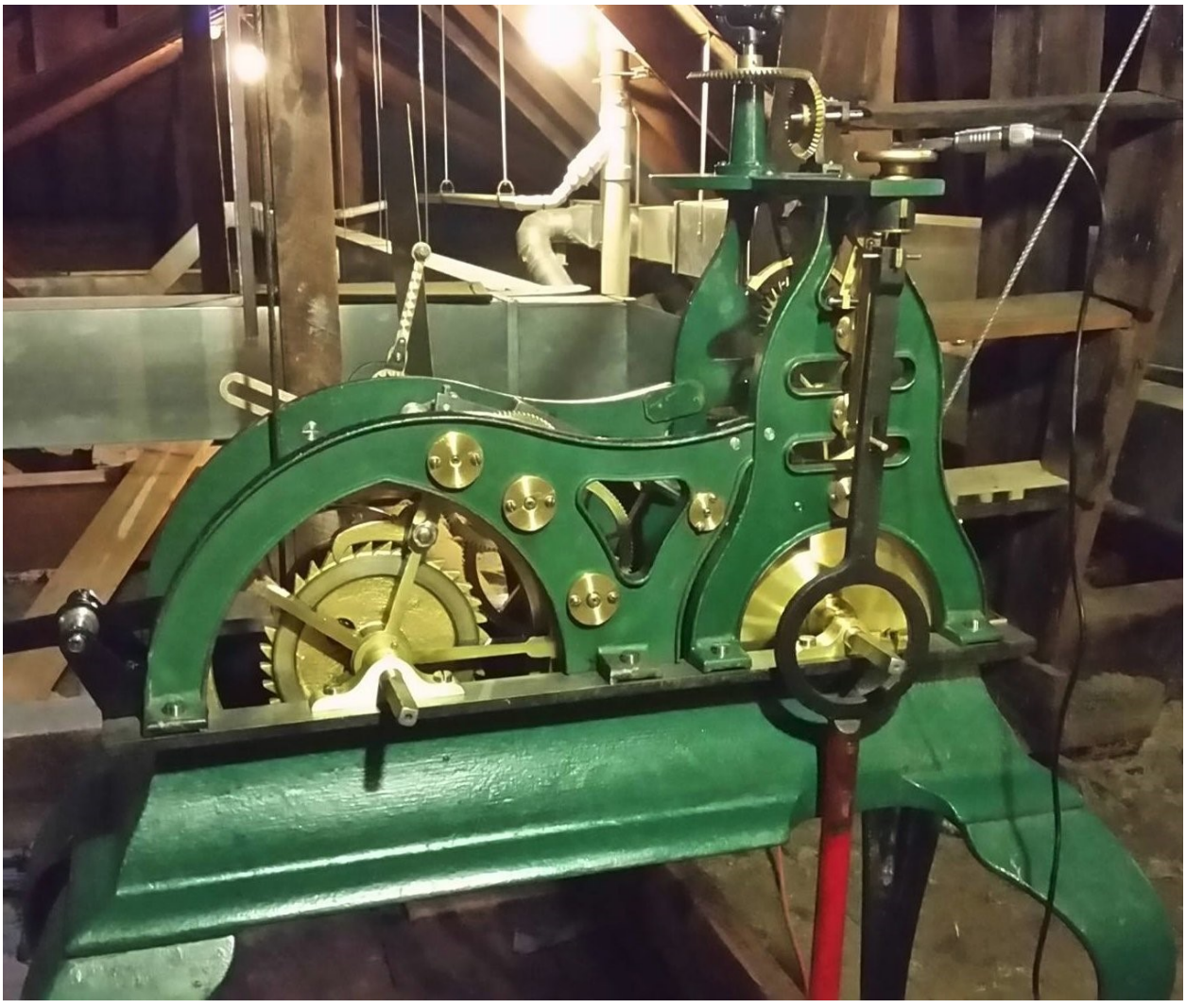
# Tower Clock Maintenance



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Cranbury Township
Clock Winding Committee

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2nd Edition: October, 2018

# DIRECTIONS
# FOR THE CARE OF A TOWER CLOCK.

Wind the clock at a uniform time, once a week, being careful to put the pin in the stud after the key is put on to it, on the clocks that are arranged to be wound in this manner. Where the winding stud is square there is no provision made for this pin.

To set the clock on time, pull out the pin that goes through the centre-wheel, and into a hole in a plate that has 60 holes, each representing a minute of the hour; hold the pin out, while with the other hand take hold of the bevel-wheel, on the lower end of the perpendicular shaft, connected with the dial-wheels above, and turn until the pointer at one of the bevel-wheels at the top of the clock indicates the desired time, then let the pin fall into the hole opposite it. If it be a striking clock, and the time for striking has to be passed when setting, wait at that point of striking, until the clock finishes striking, before moving farther. If the clock is a few minutes too fast, wait until the clock shows twenty [20] minutes past the hour, and then turn the clock backwards to the true time.

## TO REGULATE.

To make the clock go faster, turn the nut at the top of the pendulum the side towards you to the LEFT. To make it go slower, turn the nut at the top of the pendulum, the side towards you to the RIGHT. One whole turn of this nut will vary the rate of the clock about one half of a minute in 24 hours.

## OILING.

The pallets where they slide on the teeth of the escape wheel, and the pivots throughout the clock, should be examined as often as every two months; and whenever there appears to be an absence of oil, they should be well oiled, first wiping off any dirt, dirty or gummy oil that may have collected. Use cotton cloths for wiping, and be particular and not leave any lint on any of the parts wiped.

Well oiled, means oiled with the proper kind of oil, and as much put on as can be applied, and not run off from the parts oiled. Great care must be used in procuring the proper oil. We always keep in stock a supply of tower clock oil in packages convenient for use.

All the pivots and movable bearings about the dial works, and their connections to the clock, that can be gotten at, should have the same attention and oiling as the movement, except the pulley sheaves.

## PULLEY SHEAVES.

The bearings of the sheaves should be oiled once each three months at least, with clock oil. The oil hole for the bearings of the sheaves is in the square end of the pulley pin just outside of the pulley frame and on the upper side of the square. The bearing is hollow and will hold considerable oil. [illegible]

**The E. Howard Clock Co.**

BOSTON, MASS., U. S. A.

# Contents

# Introduction

The purpose of this document is to present all of the relevant information needed to maintain and preserve Cranbury's historic 1906 E. Howard tower clock. It should be seen as a living document and should contain any fact or maintenance technique that is needed to keep the clock in top working order. A printed version of this manual will be stored next to the clock in the attic for reference. An electronic version will be available on the Clock Winding Committee website via the following link:

http://www.cranburytownship.org/clockwinders/maintenance-manual.pdf

While this document is over 60 pages long, only the first 12 pages deal with the common activities of the clockwinder. The bulk of the manual (almost 40 pages) describes how the clock should be oiled and greased – tasks that will be performed only four times a year and only by those who are truly interested in doing them.

Throughout this manual, **horological** terms that are presented for the first time will be formatted like **this**. Refer to the Glossary on page 61 for a brief definition of these terms.

**"Primum non nocere"**

As you read through this manual, keep in mind the Latin phrase stated above. It is generally translated as "*First, do no harm*." It's typically directed towards those in the medical profession, but it applies to clockwinders as well. If you encounter an unusual clockwinding or clock maintenance situation but are unsure how to proceed, do nothing. Reach out to other members of the Clock Winding Committee for help. If you believe that the continued operation of the clock will exacerbate the situation, stop the clock until help arrives.

# Executive Summary

A 60-page document on clock maintenance is somewhat daunting, so here are the basics that every clockwinder needs to know in order to do their job:

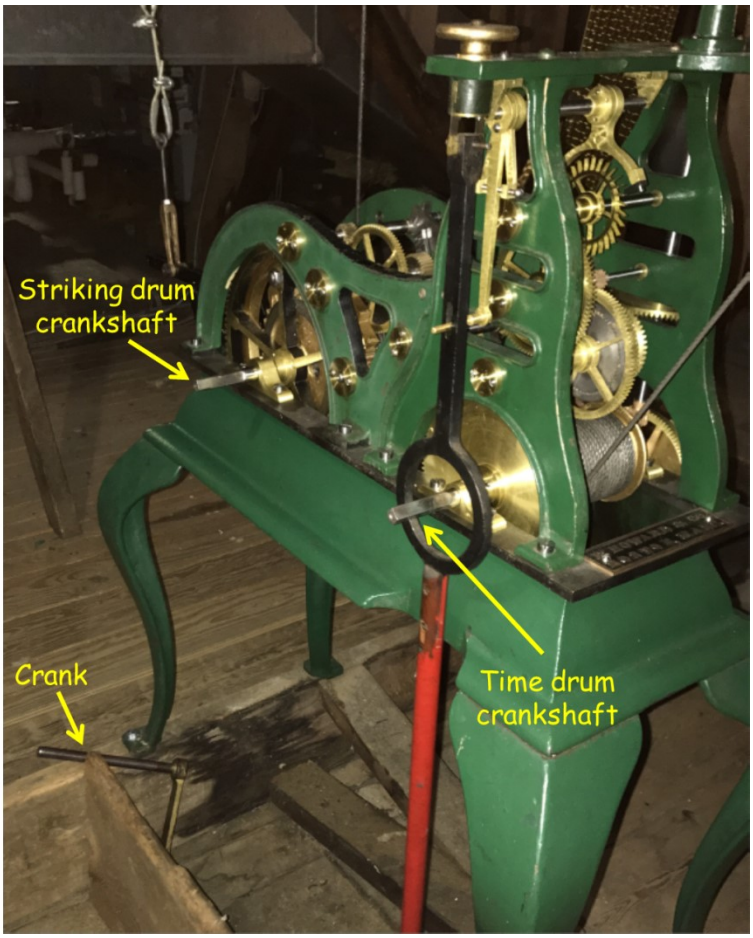
1. Wind at least every 72 hours! A fully-wound **time drum** will power the **clock mechanism** for 4-5 days, but a fully-wound **striking drum** will power the **striking mechanism** for only 3 days. (Pages 4-5)
2. The window for winding the striking mechanism closes at 35 minutes after the hour. At approximately 35 minutes after each hour, the clock will **warn**. This is a short release and arrest of the **strike train** to prepare it for the hourly strike. Per best practices, as presented in the "Turret Clock Keeper's Handbook", "*It is best NOT to wind the chiming and hour striking trains when the clock has warned*." (Page 5)
3. Don't let the striking weight bottom out! This will happen if you fail to observe rule #1. When the **striking weight** bottoms out, the striking mechanism is stuck in mid-strike until the striking drum is wound. This can't be good for the striking mechanism. If you suspect the weight has bottomed out, correct the situation as fast as possible. Fully wind the striking drum and stick around until the next hourly strike to ensure that the striking mechanism is once again functioning properly. (Page 6)
4. Don't overwind the striking drum! Overwinding the striking drum will pull the striking weight completely out of the **striking weight shaft**. If this happens you'll need one or two additional clockwinders to assist you in getting the weight back into the shaft. (Page 6)
5. Adjust the time whenever you feel it's necessary. Because of its location, the clock (for the most part) is heard rather than seen. As such, it is critical that the clock's internal time be kept in synch with actual time, allowing the clock to strike precisely on the hour. Feel free to adjust the time whenever you wind, even if it's only off by a fraction of a minute. *Regardless of whether the clock is running fast or slow, never turn the setting dial counter-clockwise*. (Page 7-8)
6. Measure carefully before regulating the clock. It is extremely easy to **regulate** the clock. It is much more difficult to determine the degree of regulation that's required. But if you find that the clock mechanism is constantly gaining or losing

time every 24 hours, do the calculation and apply the necessary regulation. Be prepared to monitor the clock closely over the next few days to determine the accuracy of your regulation. (Pages 9-11)

7. Dust! Accumulated dust and debris can clog and damage the gears of the clock. While a **dust cover** has been installed above the clock, ambient dust can still float onto the clock mechanism. As such, inspect the clock for dust or debris whenever you wind the clock and, if found, remove it. (Page 12)
8. Don't worry (too much) about the time on the clock face. Because of **backlash** and slippage within the components that control the hands of the clock, the time shown on the face of the clock may deviate from actual time by 2-3 minutes. That's normal and nothing to worry about. If the deviation is worse than this, it may be necessary to adjust the hands of the clock. (Pages 13-15)
9. Use the camera to monitor the clock remotely. The camera allows you to determine if the clock is functioning properly regardless of where you are in the world. If you're the Clockwinder on Duty, it will give you peace of mind and save you from many unnecessary trips to Town Hall. (Page 54)

# Winding the Time and Striking Drums

The act of "winding the clock" involves winding cable around two separate drums: a **time drum** that powers the clock mechanism and a **striking drum** that powers the hourly striking mechanism. When fully wound the time drum will power the clock face for 4-5 days before requiring a rewind. However, the striking drum will only power the striking mechanism for a little over 3 days. As such, the clockwinder on duty should wind both drums every 72 hours at a minimum. Below is a view of the right side of the clock showing the **crank** and the two **crankshafts**.




### Winding the Time Drum

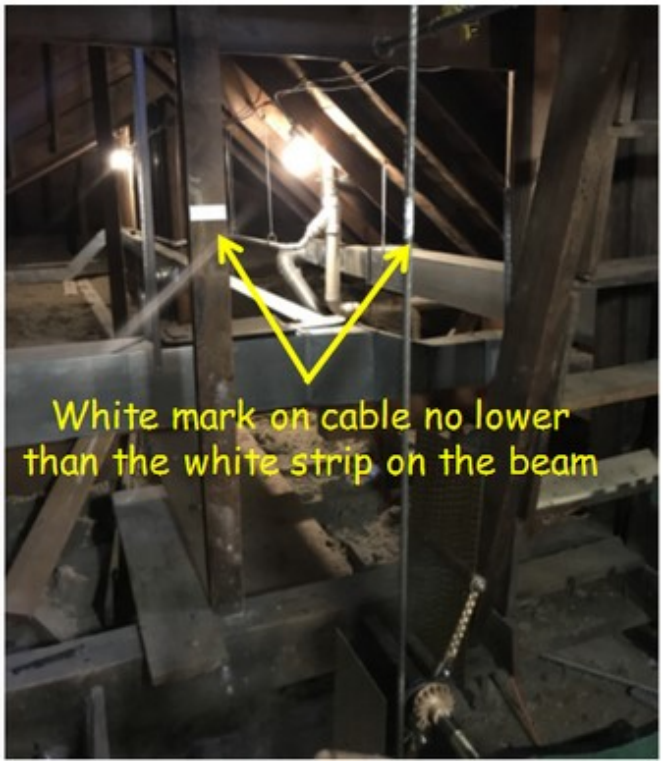
Fit the crank onto the time drum crankshaft and wind clockwise. As you wind, a portion of the cable marked in white will become visible. Stop winding when this white mark is at eye-level. At this point, the weight that powers the clock mechanism will be about a foot from the ceiling.

## Winding the Striking Drum

[***Note***: *As a result of the clock maintenance performed in 2017, a small amount of striking cable was removed and a 16" cinder block was placed at the bottom of the striking weight shaft to prevent the striking weight from getting stuck in the opening at the base of the shaft. Because of these changes, the white mark on the striking weight cable was moved in order to ensure three full days of chiming*.]

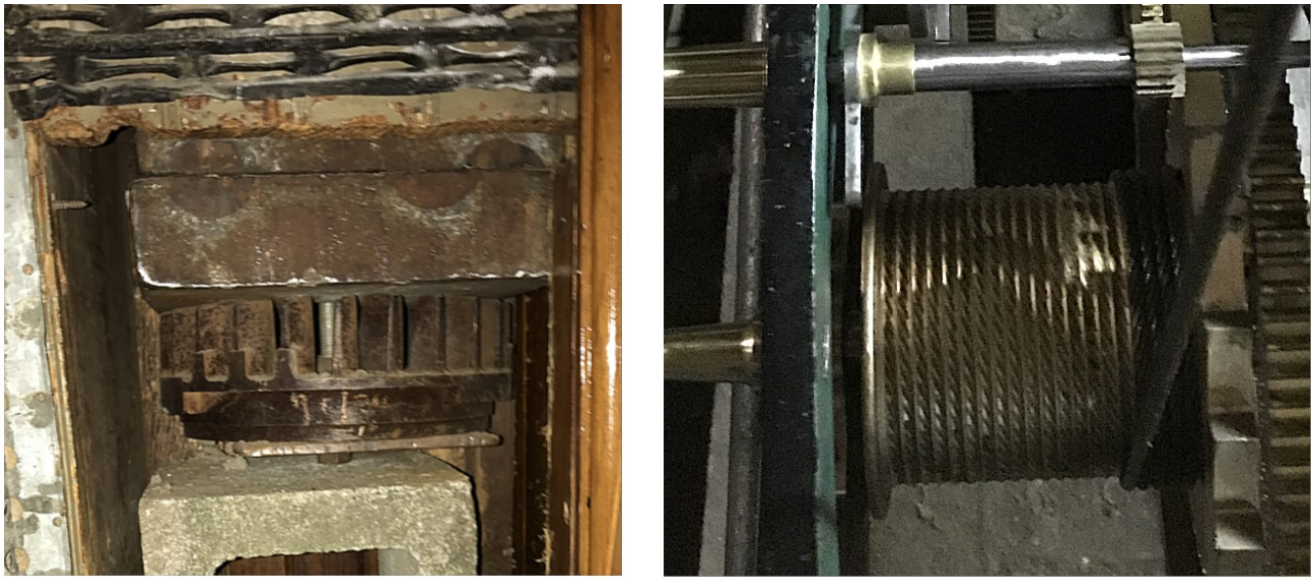
Fit the crank onto the striking drum crankshaft and wind counter-clockwise. The pictures below show the positioning of the white mark and the weight in the striking weight shaft when the striking drum is fully wound. *Do not to overwind!* Doing so could cause the weight to get stuck at the opening at the top of the shaft.

At approximately 35 minutes after each hour, the clock will **warn**. This is a short release and arrest of the strike train to prepare it for the hourly strike. Per best practice, as presented in the "Turret Clock Keeper's Handbook", "*It is best NOT to wind the chiming and hour striking trains when the clock has warned.*"



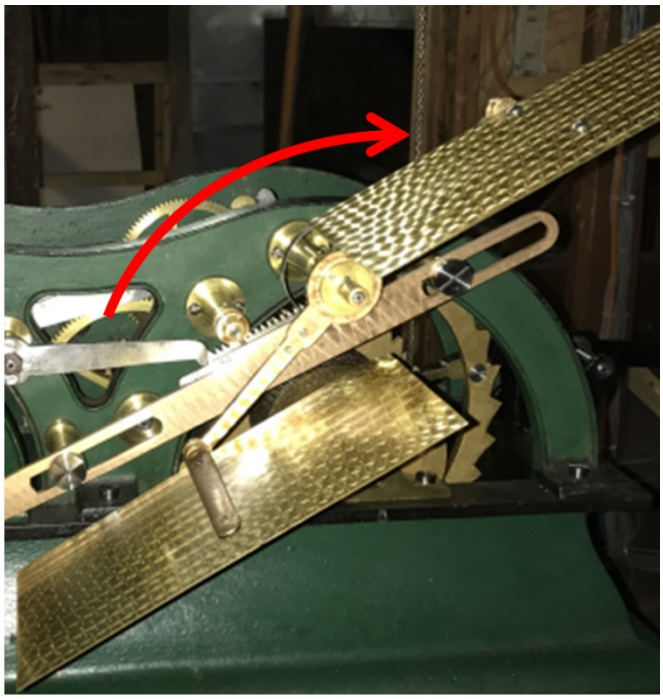

## Restarting the Striking Mechanism

Note that the striking mechanism can come to a complete halt even though there is still a bit of cable on the striking drum. This is because the striking weight bottoms out in the shaft after approximately 72 hours, as shown below:



**Striking weight resting on cinder block while a bit of cable is still on the striking drum**

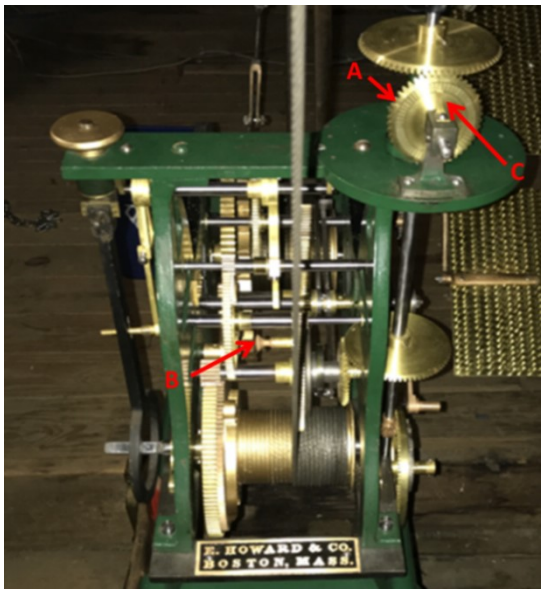
When this happens, the clock ceases to strike but (assuming the clock is still ticking) the strike-counting mechanism continues to advance. As such, simply rewinding the striking drum should correct the problem. One additional step, though, may be needed. If the striking weight bottomed out while the clock was in mid-strike (i.e. "*in the middle of a lift*") the striking mechanism may be slightly "stuck". To correct this, simply rotate the **fly fan** clockwise a bit. This will "unstick" the striking mechanism and allow it to complete its last strike. The next hour's strike should be correct.



**Rotate fan blades clockwise to complete prior strike**

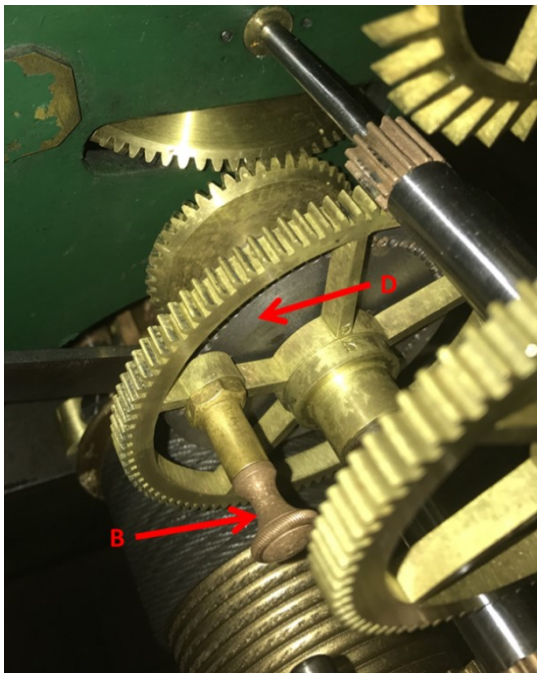
# Adjusting the Time

Occasionally, the time shown on the **setting dial** must be adjusted to synch it with actual time. Because our clock is equipped with a striking mechanism, adjustments should be made when it will not disrupt the striking process.




*Whether the clock is ahead of or behind actual time, it should be adjusted only by turning the setting dial (A) clockwise.* While it is physically possible to turn this dial counter-clockwise, doing so could result in undue strain on the leading off work and introduce **backlash** (see p. 12).

**When the clock is slow:**




- Stop the clock by gently stopping the pendulum.
- Facing the front of the clock and using your right hand, get a firm grip on the setting dial (**A**) showing the minutes of the hour.
- With your left hand, pull out the spring-loaded **setting pin** (**B**) that goes through the center wheel and into a hole in a plate **(D)** containing 60 holes (one for each minute of the hour).
- While holding the setting pin out, rotate the setting dial **(A)** *only clockwise* until the arrow (**C**) is pointing at a mark on the setting dial that is a few minutes ahead of actual time.
- Release the setting pin and ensure that it falls securely into a hole on the plate **(D)**. (Note: do not release your grip on the setting dial until the setting pin is secure.)
- Let the clock run a minute or two. Stop the pendulum when the setting dial is pointing directly at a minute mark. Re-start the pendulum when actual time matches the exact minute pointed to by the arrow **(C).**

Follow this procedure at the start of Daylight Savings Time to "spring" the clock ahead.

### When the clock is fast:

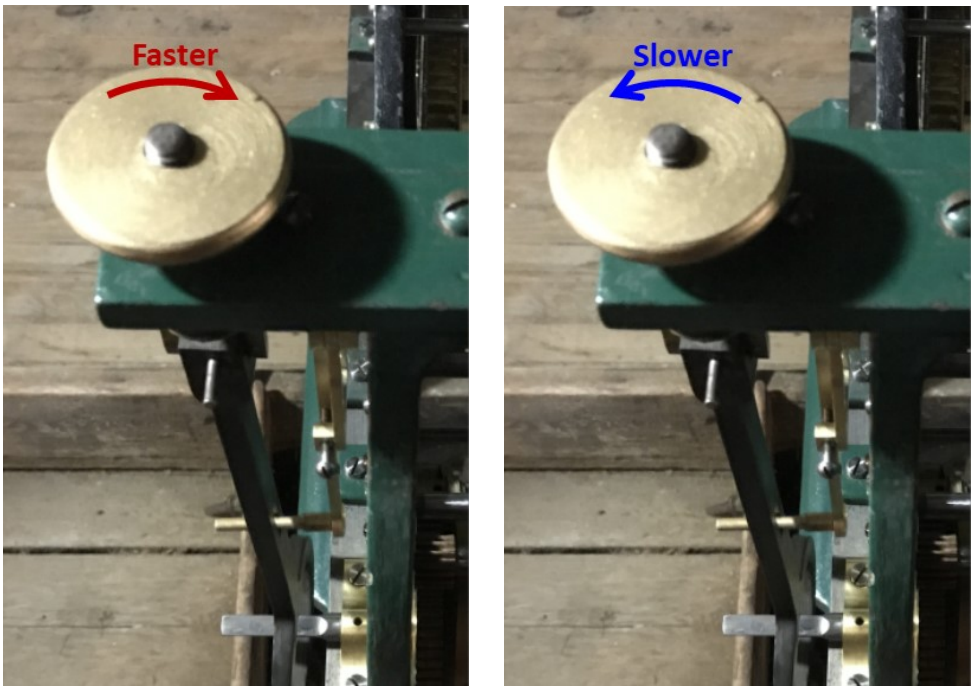
If the clock is only a minute or two ahead of actual time, the natural impulse might be to follow the above procedure and simply turn the setting dial counter-clockwise instead. This is ***not*** recommended and could do more harm than good (see Page 12). Instead, perform the following steps:

- Wait until the arrow **(C)** in front of the setting dial **(A)** is pointing directly at a minute mark in the future.
- Stop the clock by gently stopping the motion of the pendulum.
- Gently re-start the motion of the pendulum at the exact minute pointed to by the arrow **(C)**.

Follow this procedure at the end of Daylight Savings Time by stopping the pendulum and re-starting it after an hour has elapsed.

# Regulating the Clock

In a perfectly controlled environment, the clock would always run at a constant rate, controlled by the length of the pendulum. In reality, lubrication, dirt, heat and humidity also contribute to the speed of the clock. If you are constantly adjusting the clock in order to keep it in synch with actual time, you may need to regulate it – speed it up or slow it down – at various times of the year. *Making the pendulum longer slows the clock; making it shorter speeds it up.* As shown below, turning the **regulator knob** on the top of the pendulum clockwise shortens the pendulum and makes the clock run faster. Turning the knob counter-clockwise lengthens the pendulum and makes the clock run slower.




Per the instructions written in the 1890's by the **E. Howard Clock Company** (see the inside cover of this manual), a complete 360 degree turn of the knob will speed up or slow down the clock by 30 seconds every 24 hours. In practice, however, this no longer appears to be the case. As such, a conservative approach should be taken when regulating the clock.

- Determine by observation over the course of two or more day, the average number of seconds that are gained or lost by the clock over a 24 hour period.
- Divide this number of seconds by 30 to determine how much (per the original E. Howard instructions) the knob needs to be rotated.

- Before rotating, take a photo from above the pendulum so that you have a record of the knob's initial position.
- Rotate the knob ***half as much*** as suggested by the original E. Howard instructions.
- Enter a detailed description in the log of exactly what you did and why.
- Return in exactly 24 hours and document the effect of your action in the log.
- Repeat the process, speeding up or slowing down the clock as necessary, always rotating the knob ***half as much*** as suggested by the E. Howard instructions.

**Example**: Assume that after 2-3 days of observation the clock is found to be gaining 30 seconds every 24 hours:

- Take a photo documenting the initial state of the knob. (see photo below)
- Per the E. Howard instructions, the knob requires a full turn counter-clockwise to slow it down. Instead, rotate the knob one-half of a turn counter-clockwise. Document your actions in the log.
- Over the next 2-3 days, daily measurements indicate that the clock is consistently gaining 10 seconds every 24 hours.
- Per the E. Howard instructions, the knob requires one-third of a turn counter-clockwise to slow it down. Instead, rotate the knob one-sixth of a turn counter-clockwise. Document your actions in the log.
- Over the next 2-3 days, daily measurement indicates that the clock is consistently losing 4-5 seconds every 24 hours.
- At this point, you may elect to either continue with increasingly smaller adjustments (e.g., rotate the knob one-twelfth of a turn clockwise) or leave the clock as is and simply adjust the time when needed to bring it in synch with actual time.


As a rule, pendulum clocks run faster in the winter and slower in the summer due to the impact of heat and humidity on the pendulum. The cold weather causes the pendulum to shrink a bit, causing the clock to run fast. Conversely, the hot, humid summer months cause the length of the pendulum to increase a bit, causing the clock to run

slower. In 2018, when this section was last revised, the clock was being regulated twice: once in the summer and once in the winter. At that time, the following settings appeared to be fairly accurate:

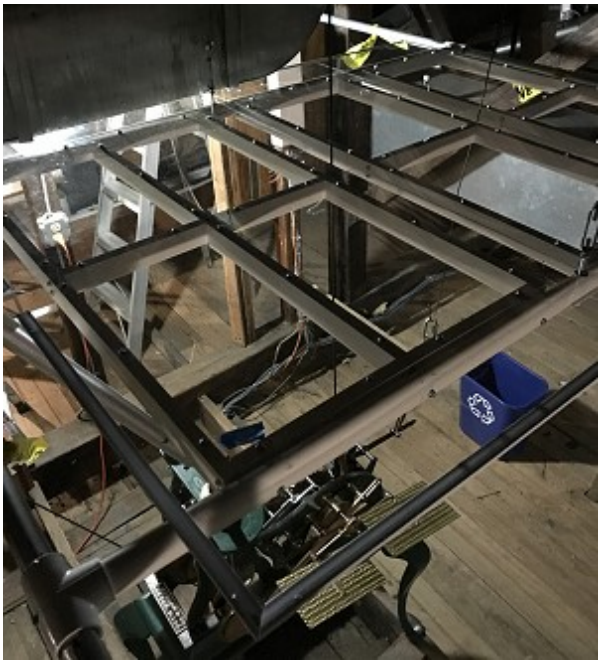
**Summer Regulating**: As the weather got warmer in the spring, the regulator was periodically turned clockwise to speed up the clock. At the hottest point of the summer, the nick pointed roughly at 2 o'clock.

**Winter Regulating**: As the weather got cooler in the fall, the regulator was periodically turned counter-clockwise to slow down the clock. At the coldest point of the winter, the nick pointed roughly at 12 o'clock.

The actual settings will undoubtedly change as time goes by and will always depend upon the conditions in the attic.

# Dusting

The 2017 clock maintenance pointed out the need to protect the gears of the clock mechanism from dust and grit falling from the rafters. To provide a degree of protection, a series of acrylic panels were suspended over the clock mechanism to provide a **dust cover**, as shown in the photo on the right. Clearly, the clock is not completely enclosed. Due to air currents within the attic, small particles of dust and grit can still enter from the sides and settle on the clock. As such, the clock mechanism should be inspected and (if needed) dusted by each Clockwinder on a monthly basis.



A small paint brush has been provided for this purpose and will be kept by the log book. Things to be aware of while dusting the clock:

- Be sure to use the paint brush labeled “Dust”.
- Do NOT use the small brush (enclosed in a plastic bag) that is used for greasing the clock.
- Be sure to brush the dust ***away*** from the gears of the clock and not into the clock mechanism.

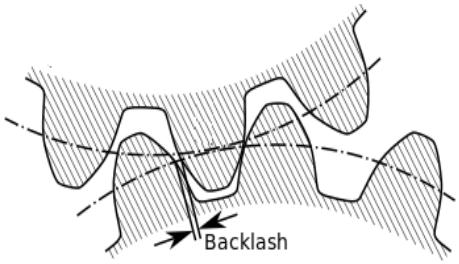
A quick, light dusting once a month should be sufficient and shouldn’t take more than a couple of minutes to accomplish.

# Adjusting the Hands of the Clock

Although the clock engine was restored to maintain very accurate time, there are a number of physical connections between the clock and the clock face which, due to cost constraints, were not addressed. Each of these connections – because of age, dirt or environmental factors – can cause the time shown on the clock face to deviate from the time maintained by the clock engine. This section describes the procedure that should be followed to adjust the hands of the clock without impacting the time maintained by the clock engine. Before doing so, the concept of **backlash** must be presented.

**What is Backlash?**

Backlash refers to lost motion in a mechanism caused by the gaps between its component parts. In the case of our tower clock, it refers to the lost motion caused by gaps or looseness in the clock's **leading off work** and **motion work**, i.e., the gears, drive shafts and **universal joints** that lie between the clock engine and the hands of the clock.




In the drawing on the right, assume that the top gear is rotating clockwise. Before it can cause the gear on the bottom to begin rotating counter-clockwise, the gap labeled "Backlash" must first be traversed. That gap represents the lost motion between the two gears. There are many such "gaps" in the leading off work and motion work of our clock. Figure 1 on the right shows the beginning segment of our clock's leading off work. Rotating the setting dial **(A)** clockwise rotates the upper gear **(B)** counterclockwise which in turn imparts rotational motion to the universal joint **(C).** Each of these interactions represents a potential source of backlash. Figure 2 on the next page shows another segment of the leading off work, this one located in the **belfry**. As before, every interaction between the component parts of the leading off work and motion work (gears, shafts, universal joints) represents a potential source of backlash.

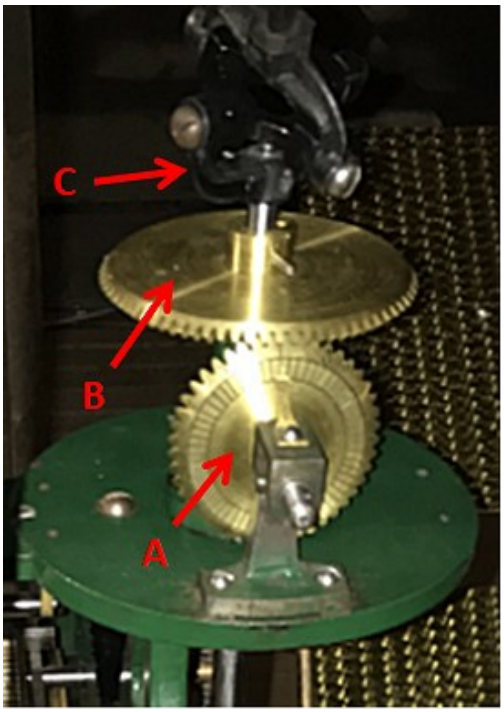



**Figure 1**

It is important to note that backlash is normal – and unavoidable – within the workings of a tower clock. When the clock is running, the backlash in each component is iteratively "taken up" (removed) until all backlash has been removed. Only then will the hands of the clock begin to turn. To prevent backlash from being reintroduced, avoid any action to the leading off work and motion work that might, even slightly, reverse the direction of the gear train.

As an example, when adjusting the clock's internal time (p. 7) a tight grip should be kept on the setting dial when the setting pin is pulled out. This will prevent the setting dial from rotating counterclockwise, even slightly.

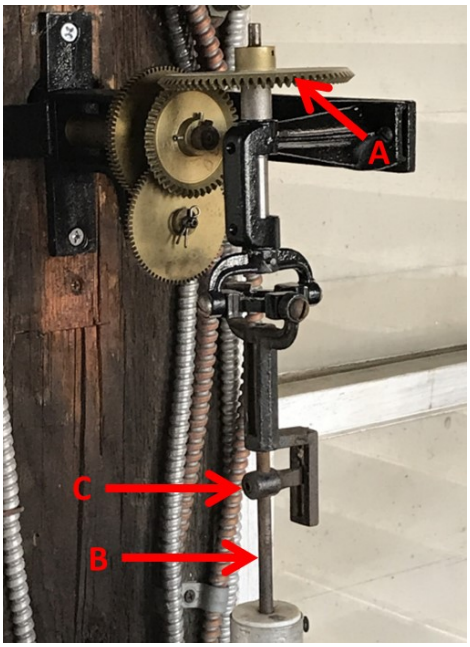


**Figure 2**

Similar care must be taken when adjusting the hands of the clock. Ensure that all component parts of the leading off work are kept in constant tension to prevent the gear train from slipping backwards and reintroducing backlash.

## Procedure:

Monitor the clock closely for multiple days and at various times of the day to confirm that an adjustment of the clock hands is needed. To adjust the hands of the clock without affecting the time maintained by the clock engine itself, the leading off work in the belfry must be adjusted. Three people should be involved with this process: one person outside using a cell phone to communicate with two people inside the belfry. Begin the procedure sometime between 11:30 and 12:00.

1. Referring to Figure 1 on the prior page, stop the clock by stopping the motion of the pendulum when the arrow in front of the setting dial **(A)** is pointing directly at a minute mark.
2. Following the procedure on page 7, turn the setting dial **(A)** clockwise until the arrow points directly at the 55 minute mark.
3. Proceed to the belfry.
4. Referring to Figure 2 above, while Person 1 is keeping a firm grip on the upper gear **(A)** and Person 2 is keeping a firm grip on the leading off shaft **(B)**, Person 2 should use an Allen wrench to loosen the set screw **(C)**. This disconnects the

leading off work from the motion work in the belfry, allowing the hands of the clock to be adjusted without altering the time maintained by the clock engine.

Close-up of set-screw

5. Person 1 (following the guidance of Person 3 outside with a cellphone) should turn the upper gear **(A)** of the motion work to rotate the hands of the dial clockwise until they are set to exactly 12:00.
6. Person 3 should re-start the clock by putting the pendulum in motion. When the **cam** drops at 12:00 and the hourly strike begins, stop the pendulum immediately. This will remove backlash from the lower drive chain.
7. Person 2 should then tighten the set screw **(C)** with the least disturbance possible to the drive train.
8. At this point, Persons 1 and 2 can release their grip on their components.
9. Adjust the internal clock time by rotating the setting dial to correspond to the actual time (see p. 7) and then re-start the motion of the pendulum.

# Oiling

## Overview

The inside cover of this manual holds a one-page set of instructions from the E. Howard Clock Company describing how to care of the clock. Half of these instructions deal with oiling and can be summarized as follows:

- Oil both pallets of the escapement;
- Oil all pivots;
- Oil all movable bearings;
- Oil the bearings of the pulley sheaves.

Pretty simple, right? The devil, as they say, is in the details. In truth, there are over 50 specific points that must be oiled every 90 days. This section will provide the details of doing this. Before beginning, though, here are a few basic points:

Figure 1

- Regular oiling is needed to minimize friction and wear between points of contact.
- The type of oil is important. Use only the J. D. Windles clock oil stored in the attic in the small oiling bottle shown on the right. The needle applicator allows a small, controlled amount of oil to be delivered to each oiling point.
- The quantity of oil is important. In most cases, a drop or two of oil will be sufficient. Too much oil will overflow and cause the oil to be drawn away from its actual target. Drips caused by excess oil (as shown in Figure 2) should be immediately wiped away.
- Oil applied to the wrong place (e.g., gear teeth) will cause dust to be retained and will accelerate wear.
- To avoid confusion oil one side of the clock at a time. Do not try to go back and forth between the two sides of the clock.

Figure 2

- Do not wind the clock until after oiling. This will allow you to adjust the winding drums, if needed, to apply oil more easily

## Arbors, Pivots and Bushings

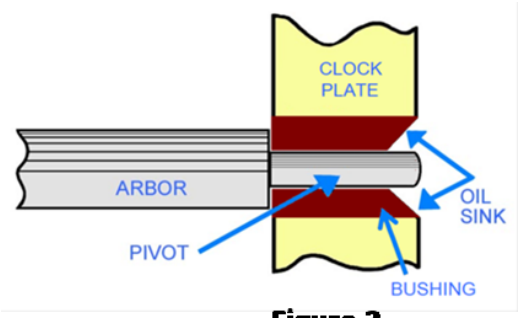



**Figure 3**

Much of what needs to be oiled are metallic axles or arbors that come in contact with another metallic part as they rotate. As shown in Figure 3, an **arbor** is often attached to the **clock plate** (or clock wall) by a **bushing**. The narrow end of the arbor that inserts into the bushing is called a **pivot**. As the arbor rotates, the pivot will be constantly rubbing against the walls of the bushing. As such, it must be regularly oiled by applying oil at the **oil sink** surrounding the pivot as it extends from the bushing.

**Figure 4**

In some cases, the arbor may be clamped to the clock plate as shown in Figure 4. Since the arbor will be constantly rubbing against the clamp as it rotates, it must be oiled regularly via the hole at the top of the clamp.

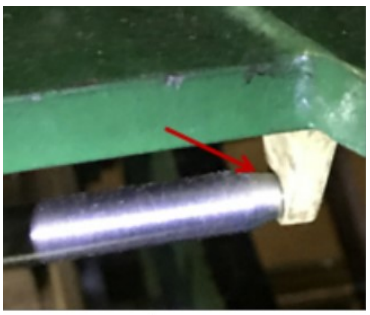


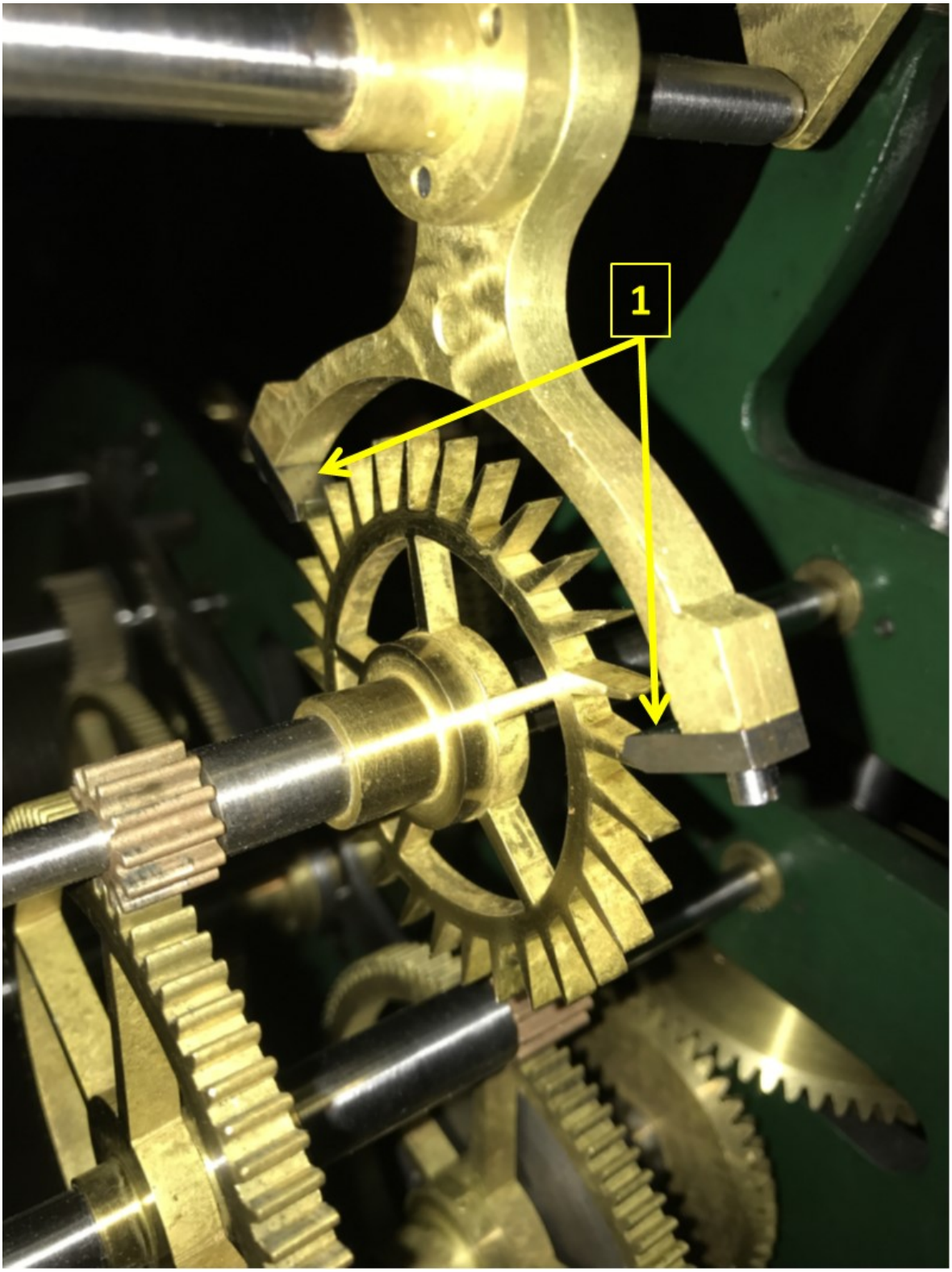
**Figure 5**

There will also be instances where the arbor is attached to the clock plate by mechanisms other than a bushing or a clamp, as shown in Figure 5. A drop or two of oil applied where indicated by the red arrow will allow the oil to wick into the pivot and provide the necessary lubrication.

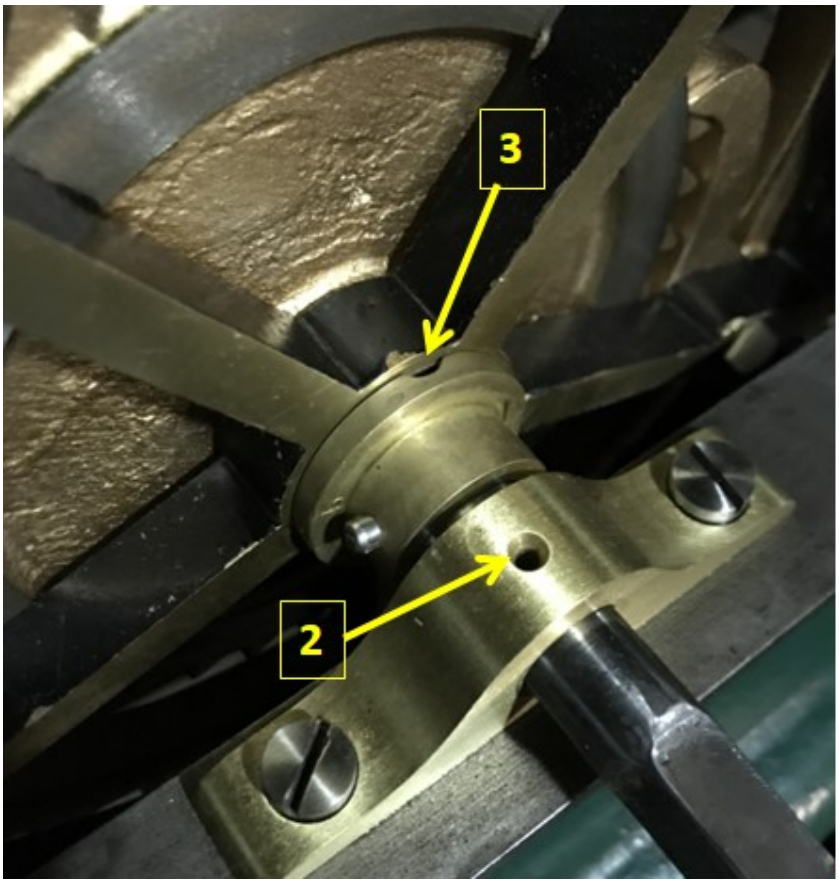
The specific oiling instructions presented in the next few pages will use the following orientation for the clock:

- The front contains the brass nameplate.
- The back contains the striking mechanism.
- The left contains the **fly fan**.
- The right contains the crankshafts used for winding.

# Oil Points on the Right Side of the Clock



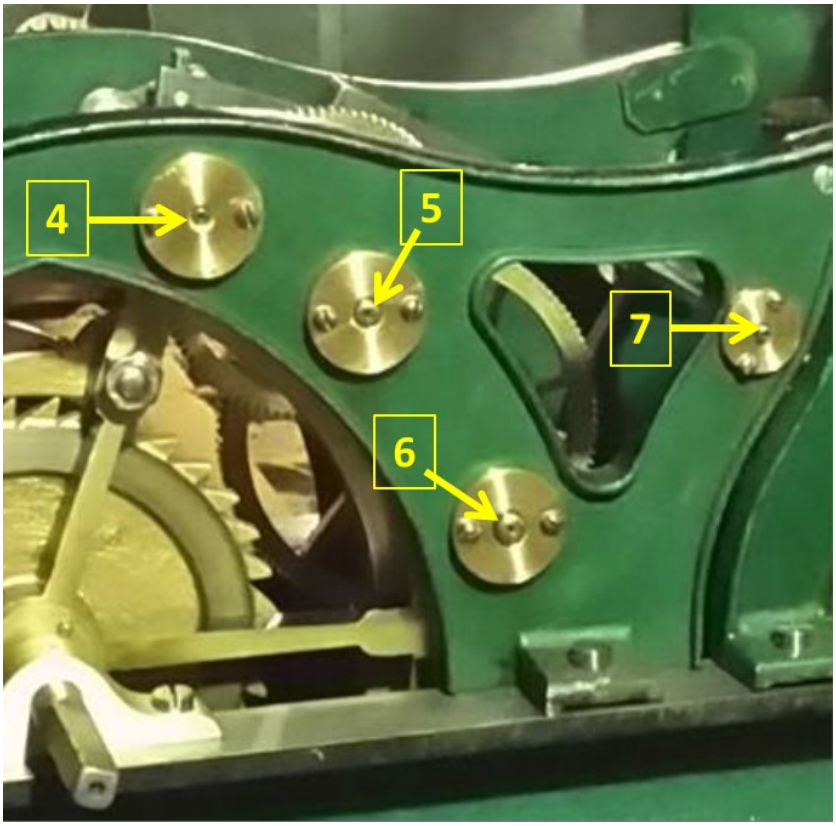

Place a drop of oil on the top face of each **escapement pallet**, as indicated above. After 30 seconds or so, put another drop of oil at each location. This should serve to lubricate all of the teeth on the **escape wheel**.

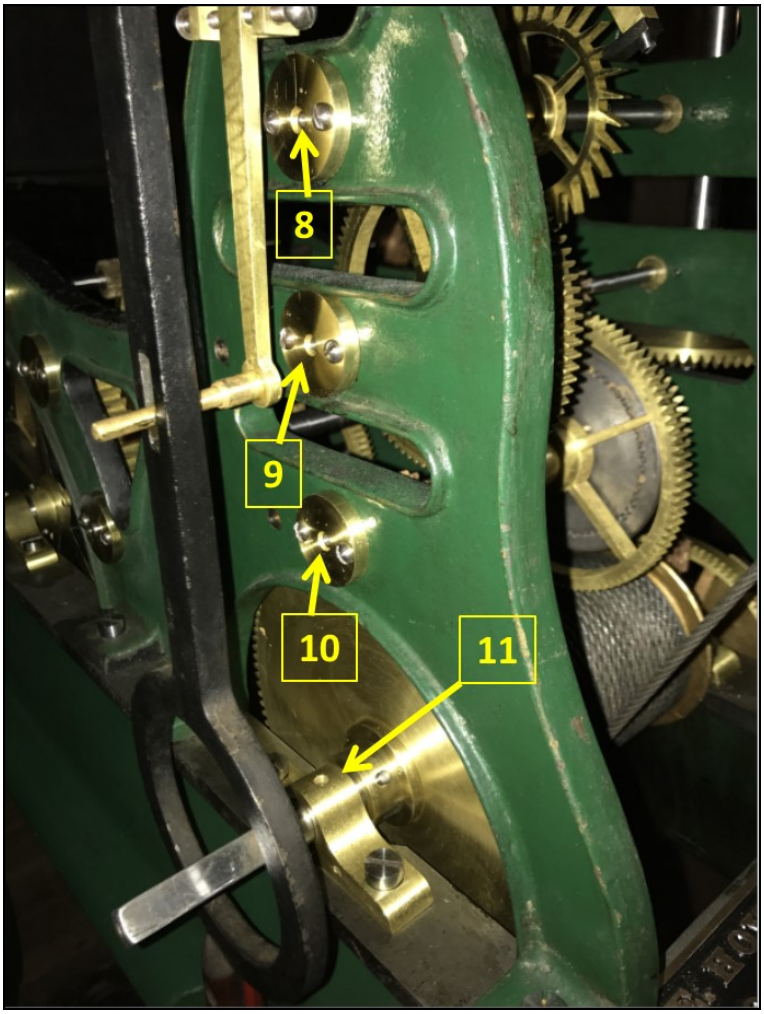


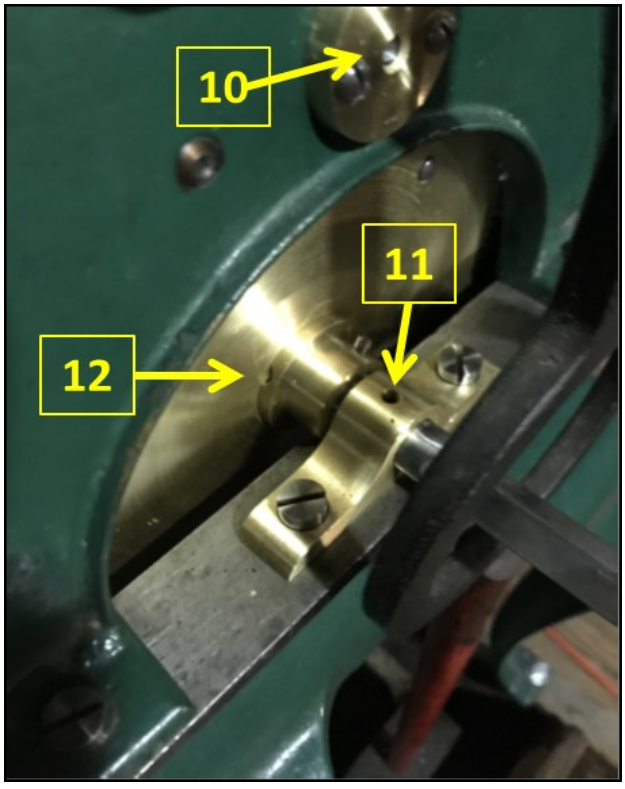

**Note**: You may need to wind the striking drum slightly to orient oil point #3 in the 12 o'clock positon prior to oiling.

**Note**: When oiling the pivot extending from the bushings, oil should be placed in the **oil sink** around the pivot, not in the hole in the center of the pivot.

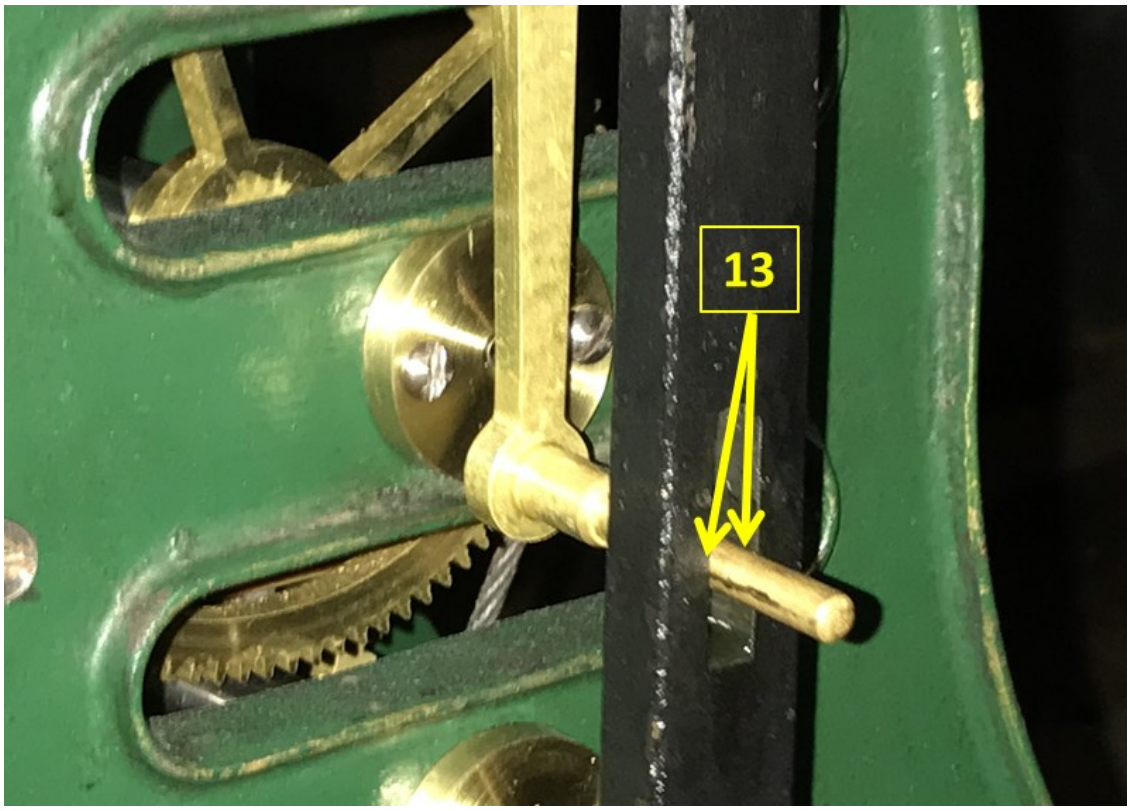
**Close-up of bushing and where to apply oil**





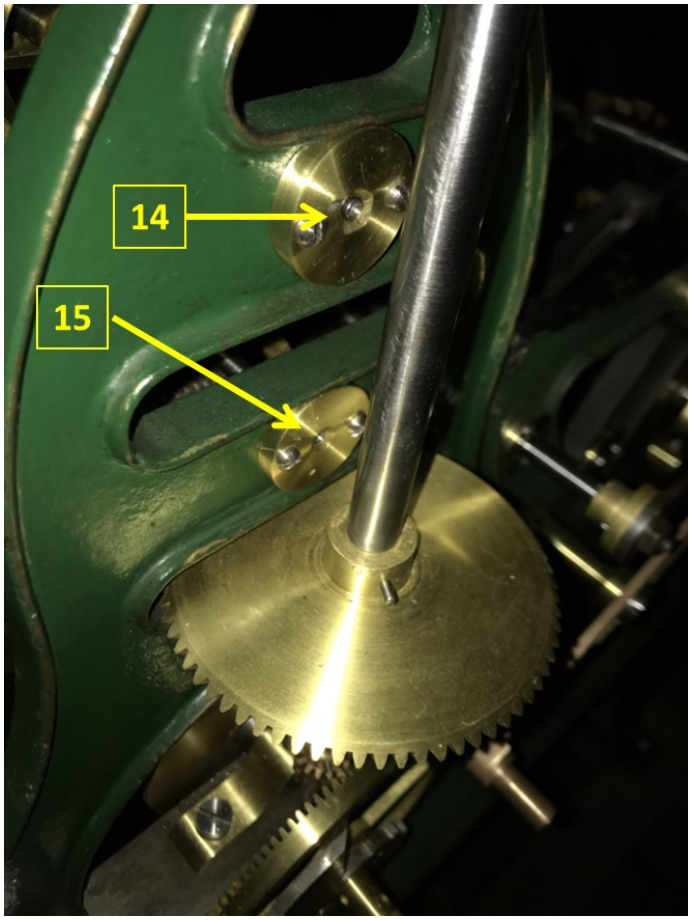




**Note**: You may need to wind the time drum slightly to orient oil point #12 in the 12 o'clock positon prior to oiling.




Put a drop of oil on either side of the **crutch pin** as it passes through the opening in the pendulum

## Oil Points on the Left Side of the Clock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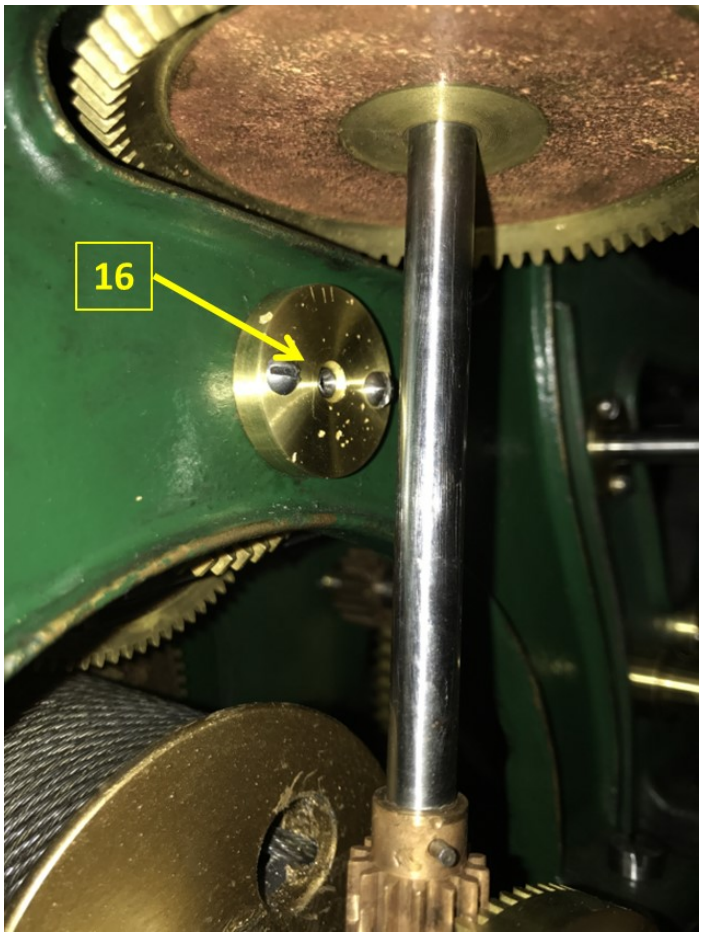
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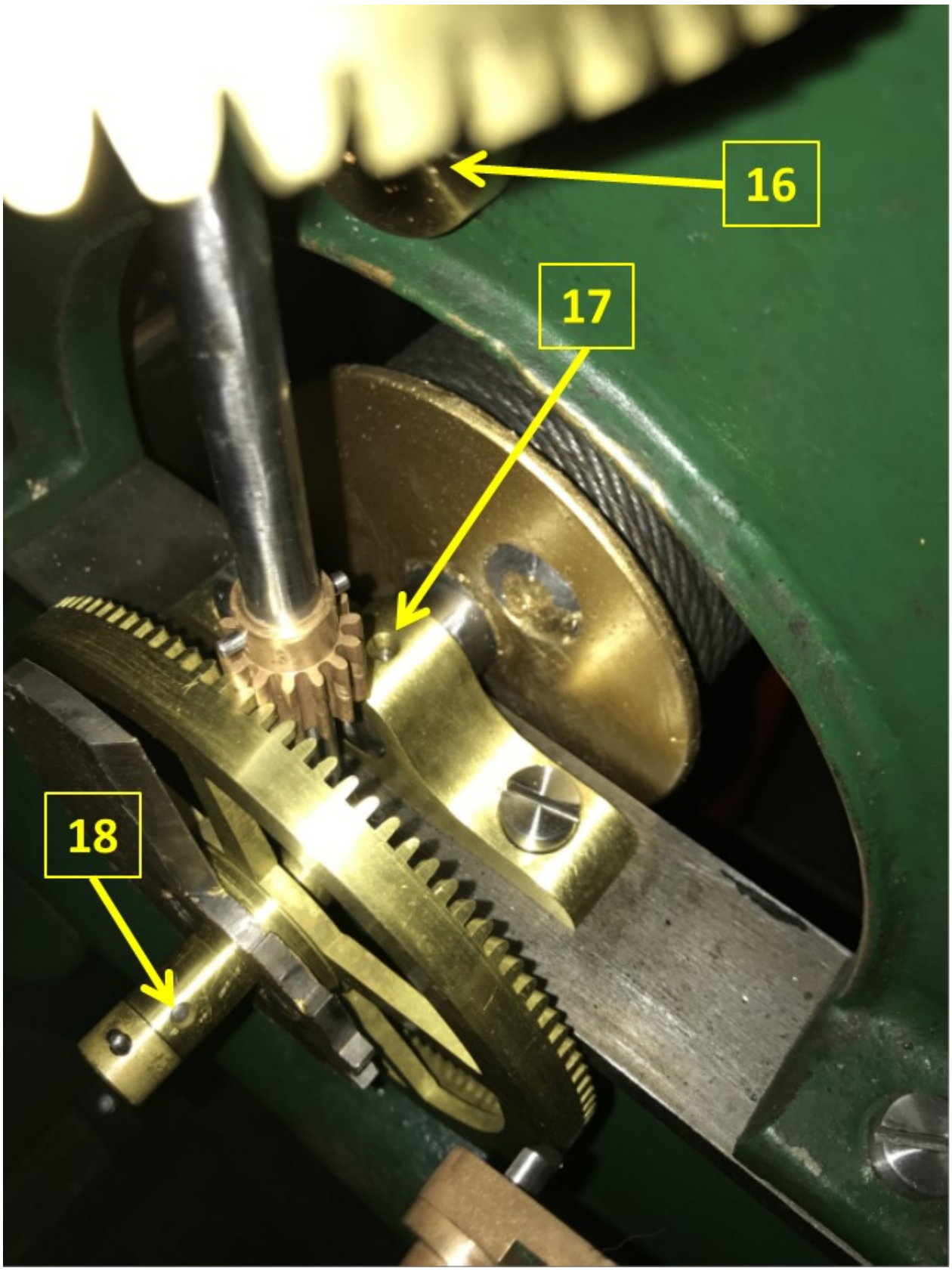
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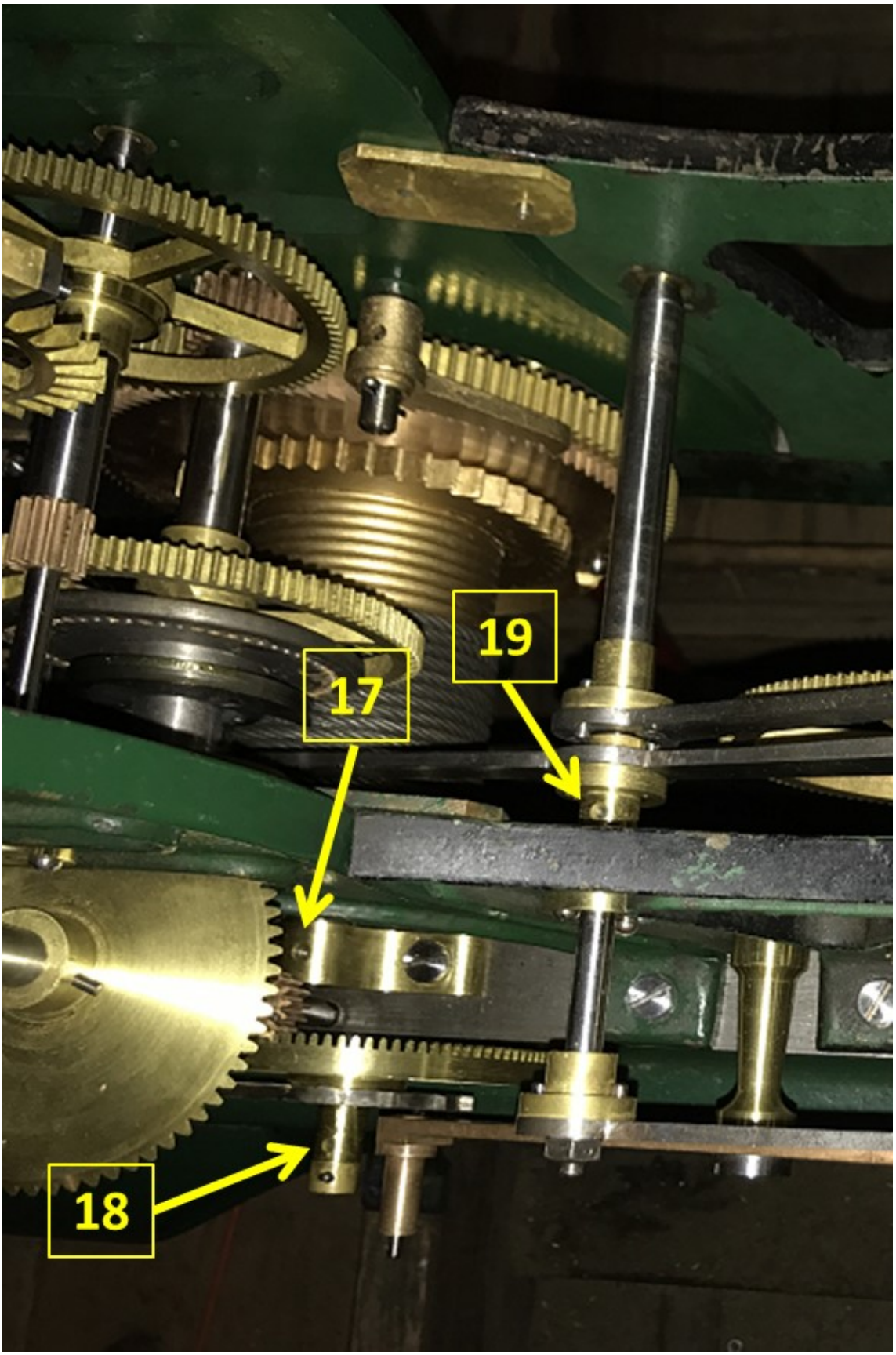
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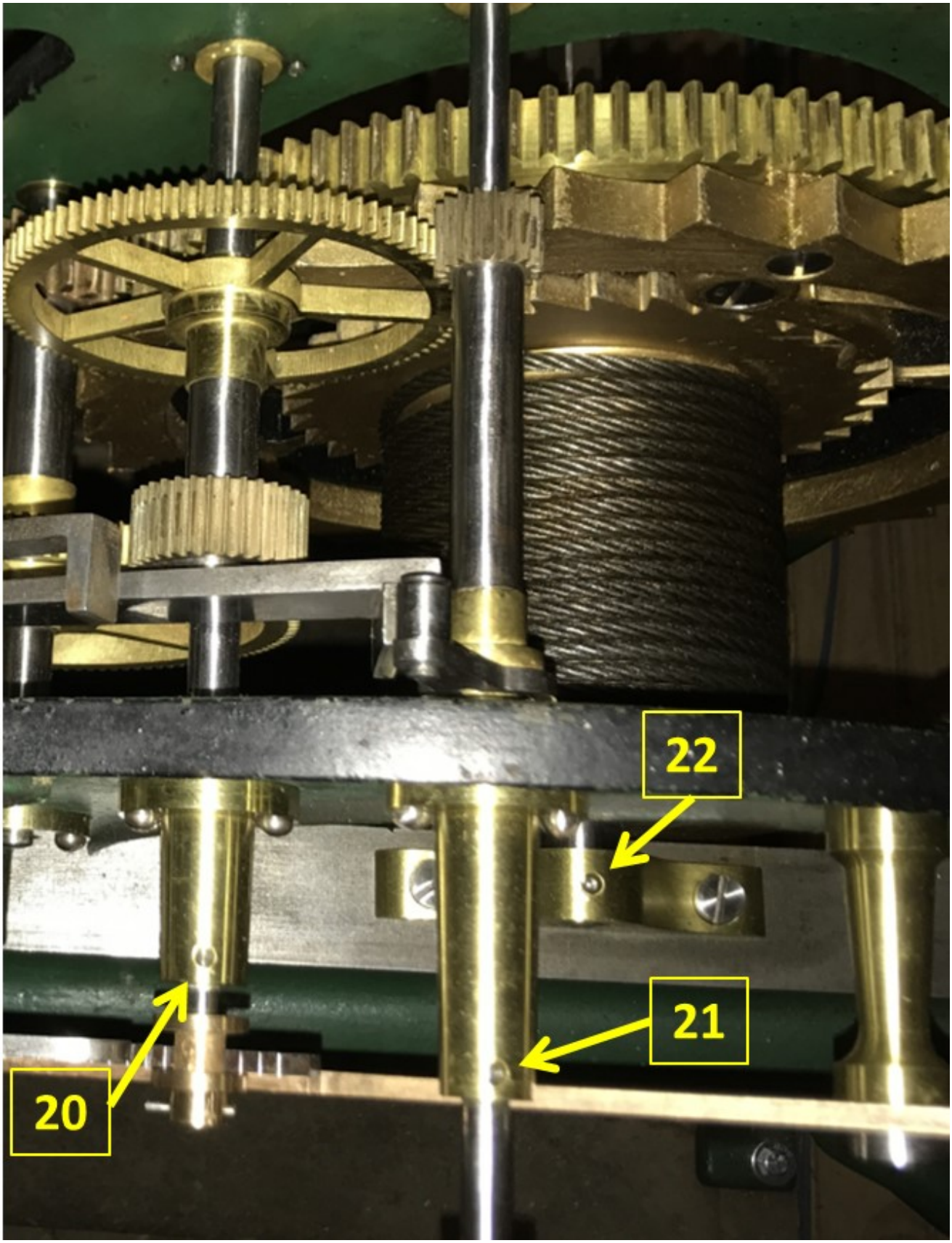
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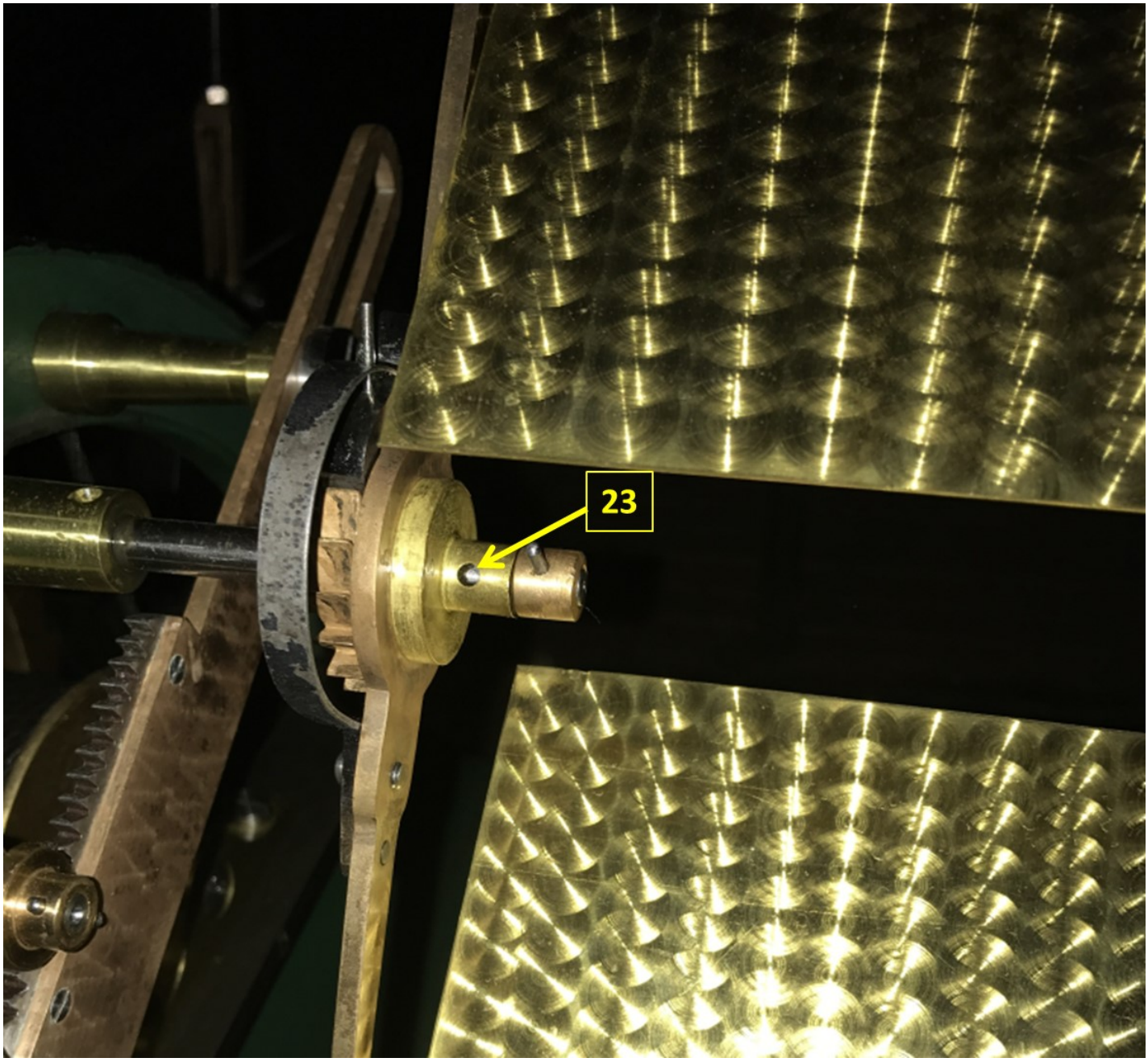
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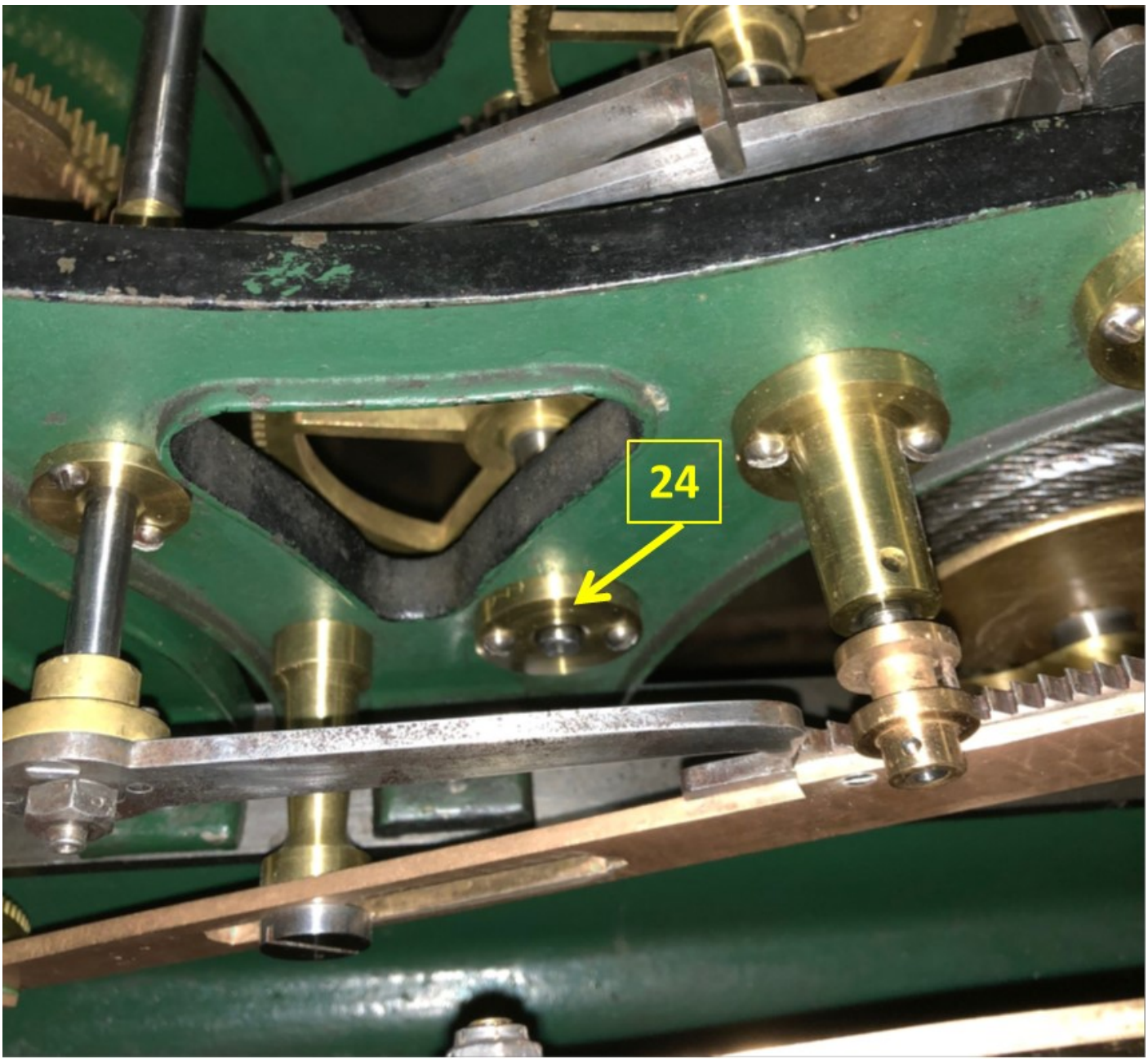
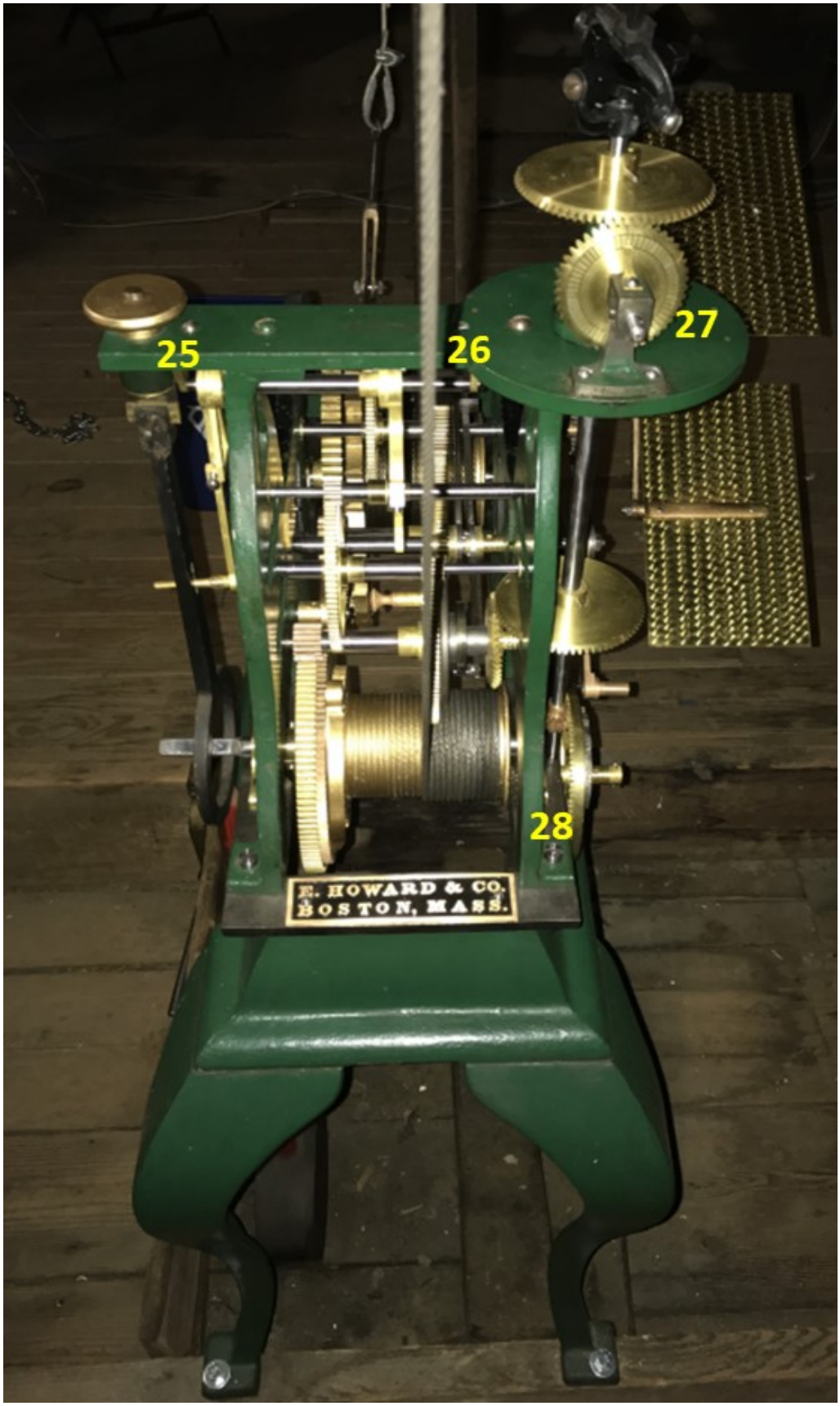
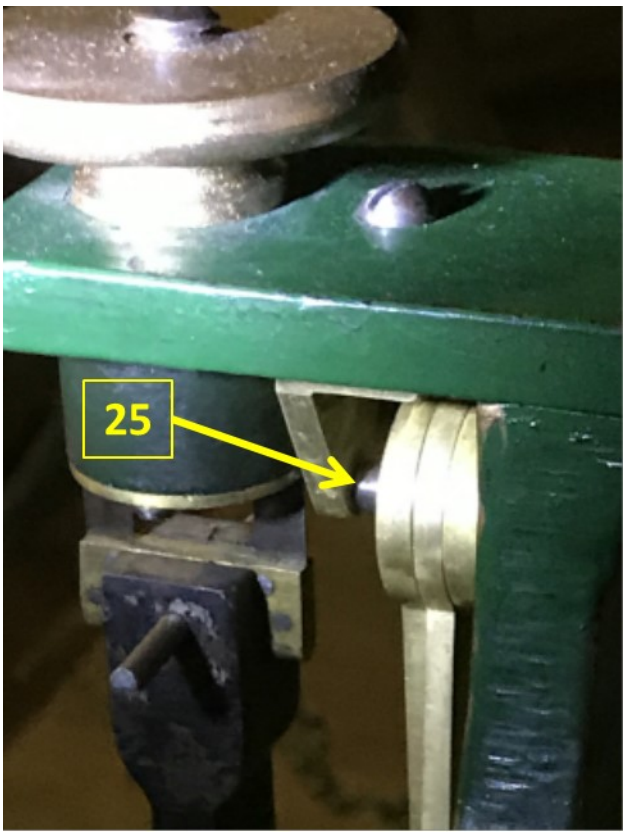
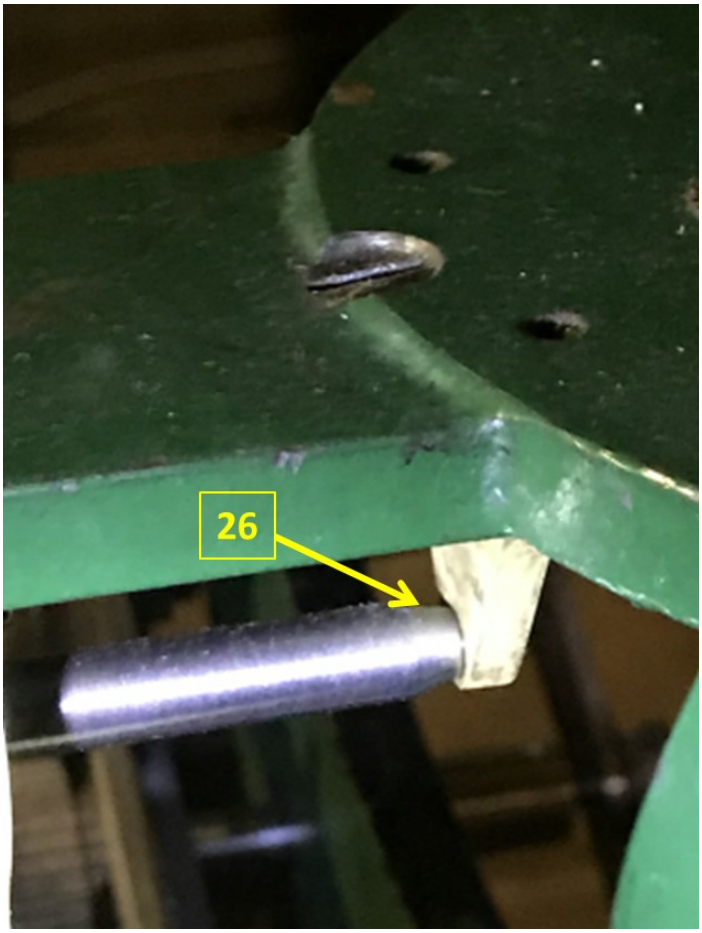

24

## Oil Points Viewed From the Front of the Clock






Note that these two oil points are the left and right ends of the same **arbor**. Unlike most other arbors, its pinions cannot be lubricated via a bushing with an oil sink.



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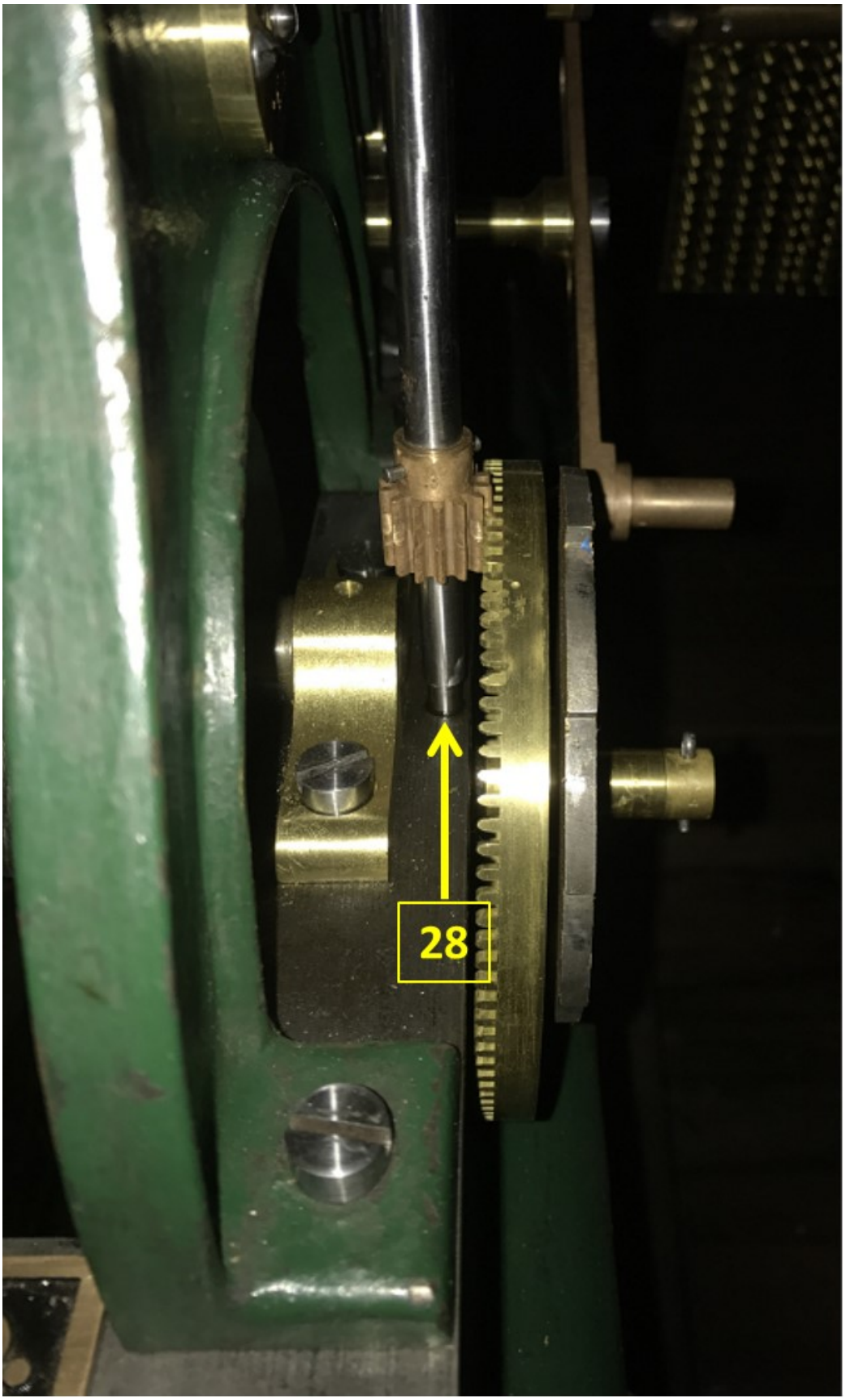
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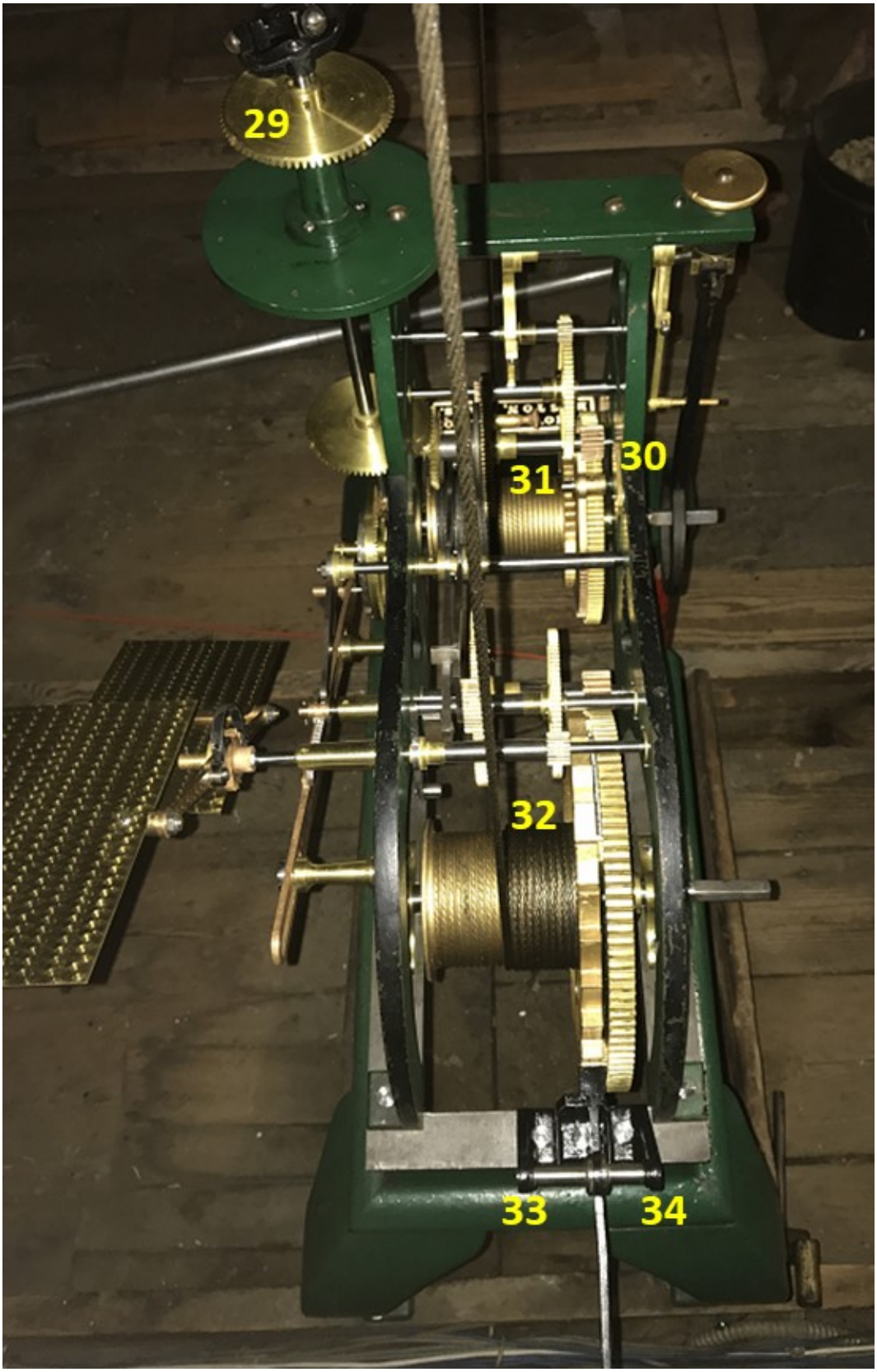
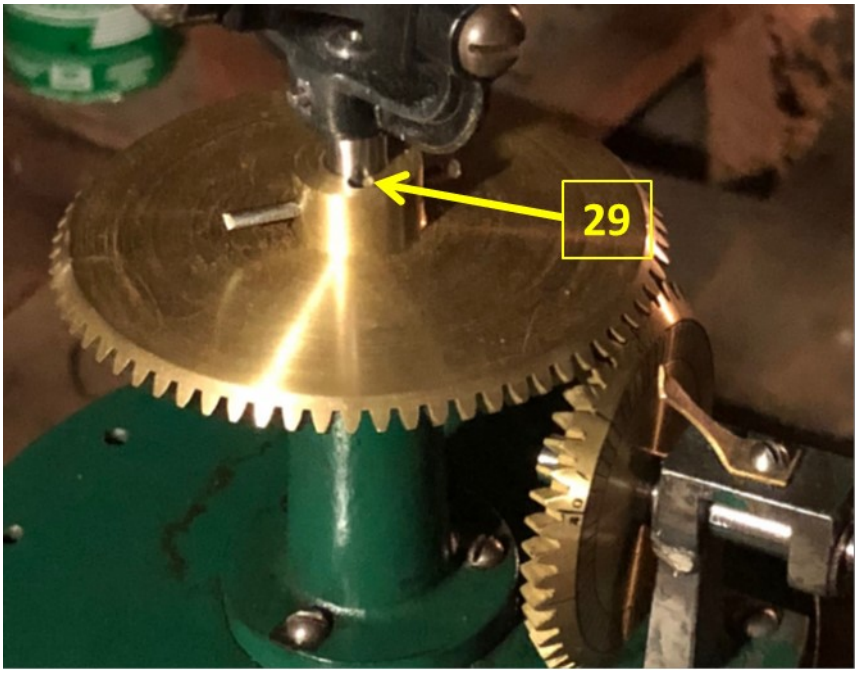
## Oil Points Viewed From the Back of the Clock

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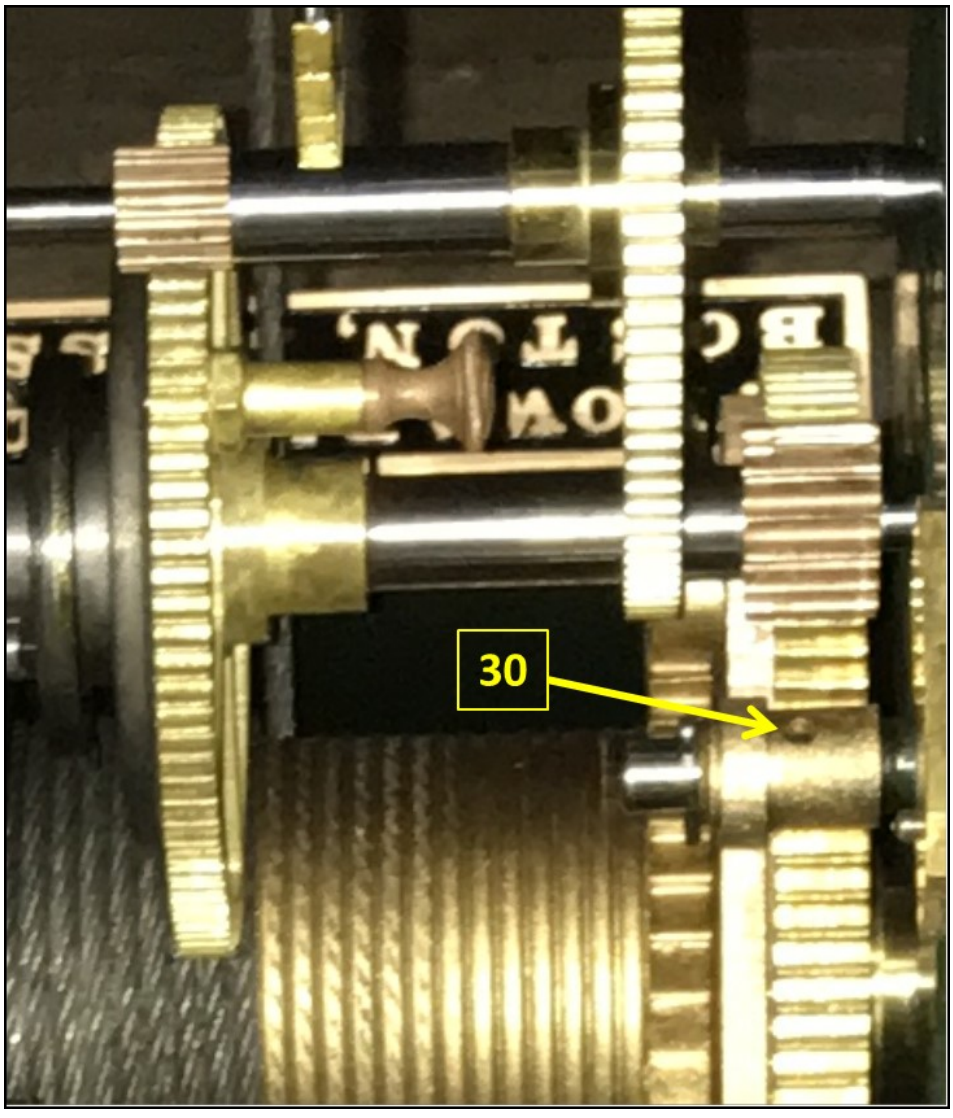
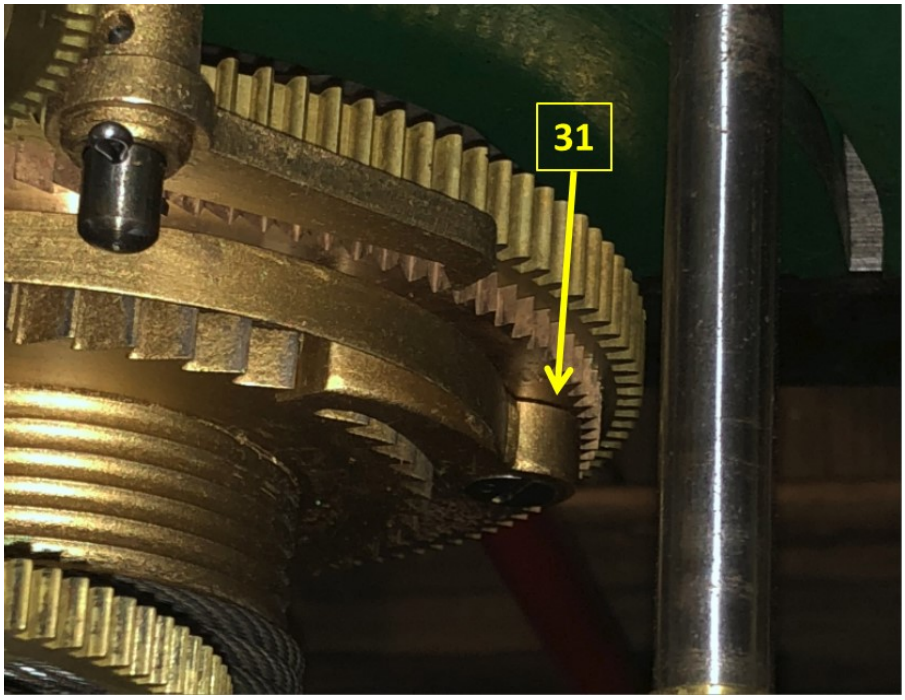
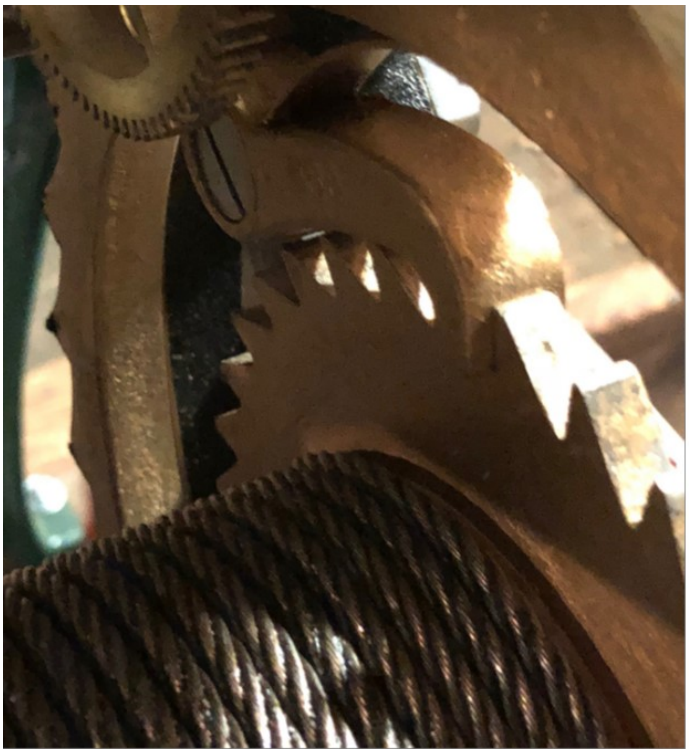
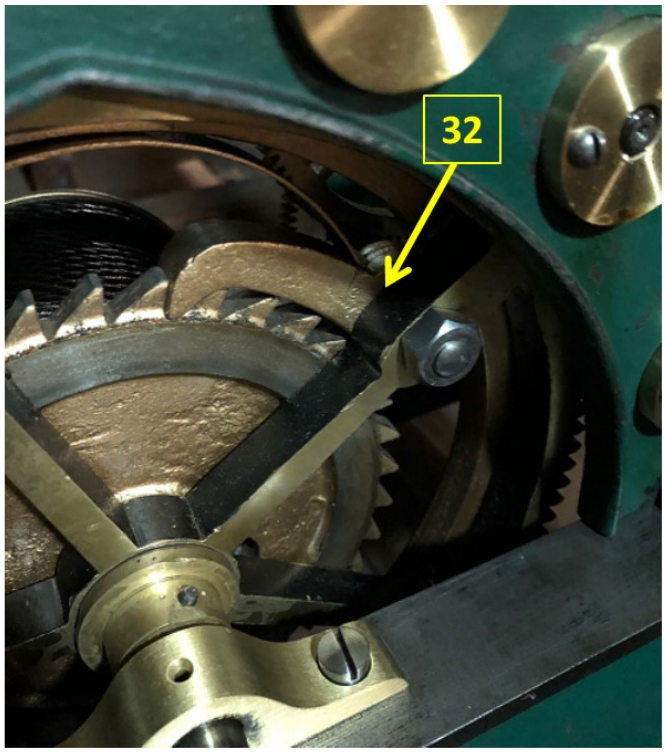

30

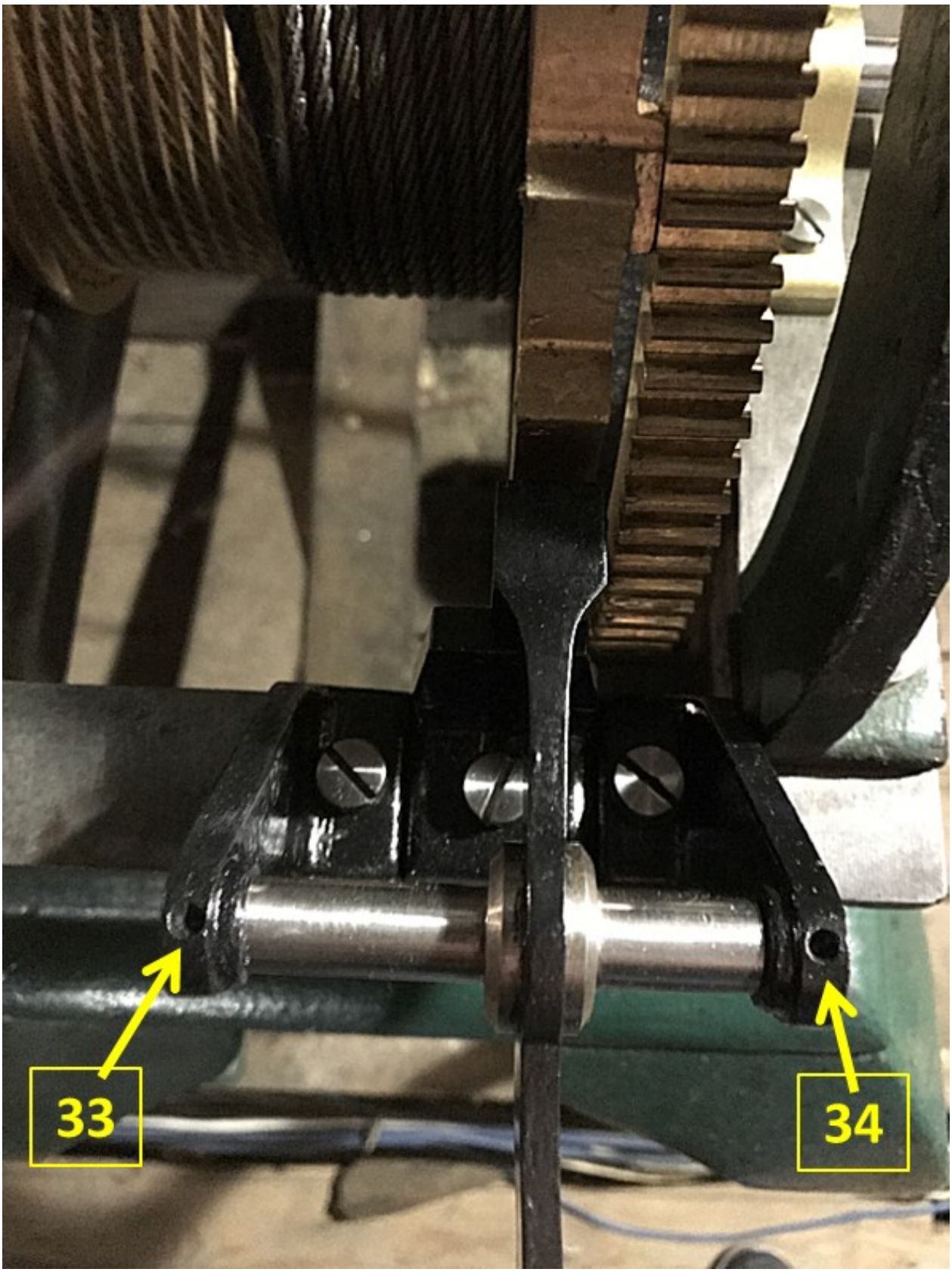
Ratchet click used to wind the clock. Place a drop of oil where indicated, between the click and the winding gear, being careful not to put oil on the gear teeth.




Two views of the ratchet click that is used to wind the striking drum. Again, oil the area where the click is attached by a screw and nut to the outer gear being careful not to put oil on the gear teeth.



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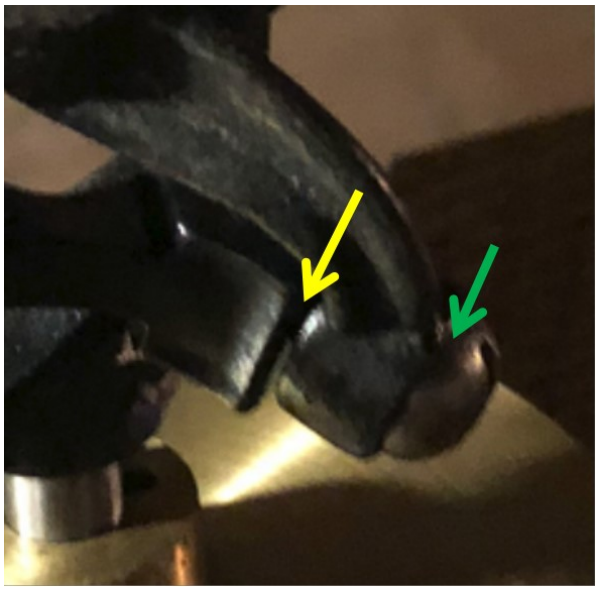
# Oiling the Leading-Off Work

The **leading-off work** consists of the rods and universal joints that transmit rotation from the gears of the clock to the **motion work**. Universal joints are used to transfer mechanical power between two shafts that are at an angle to one another.

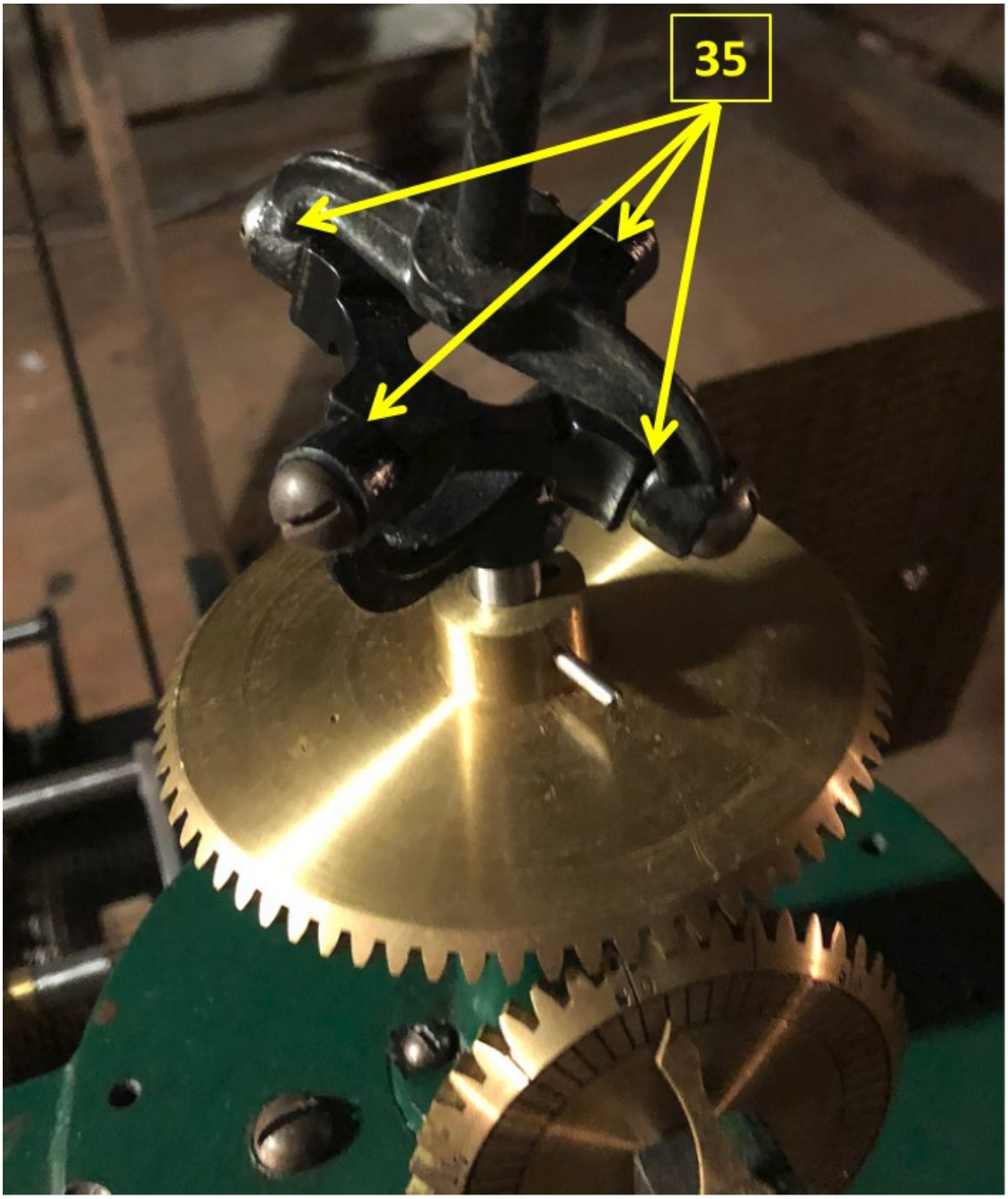
Our leading-off work utilize three universal joints. Each u-joint is comprised of an upper and lower "yoke" that are attached by screws, as shown in the photo on the right. These screws also function as shafts which allow the universal joint to rotate. Each of these shafts needs to be periodically lubricated.

The close-up on the right indicates the location where a drop of oil should be applied to each of the four screws. If it is too difficult to apply the oil at this location, apply the oil where the screw head meets the yoke. It will wick its way to the screw shaft.

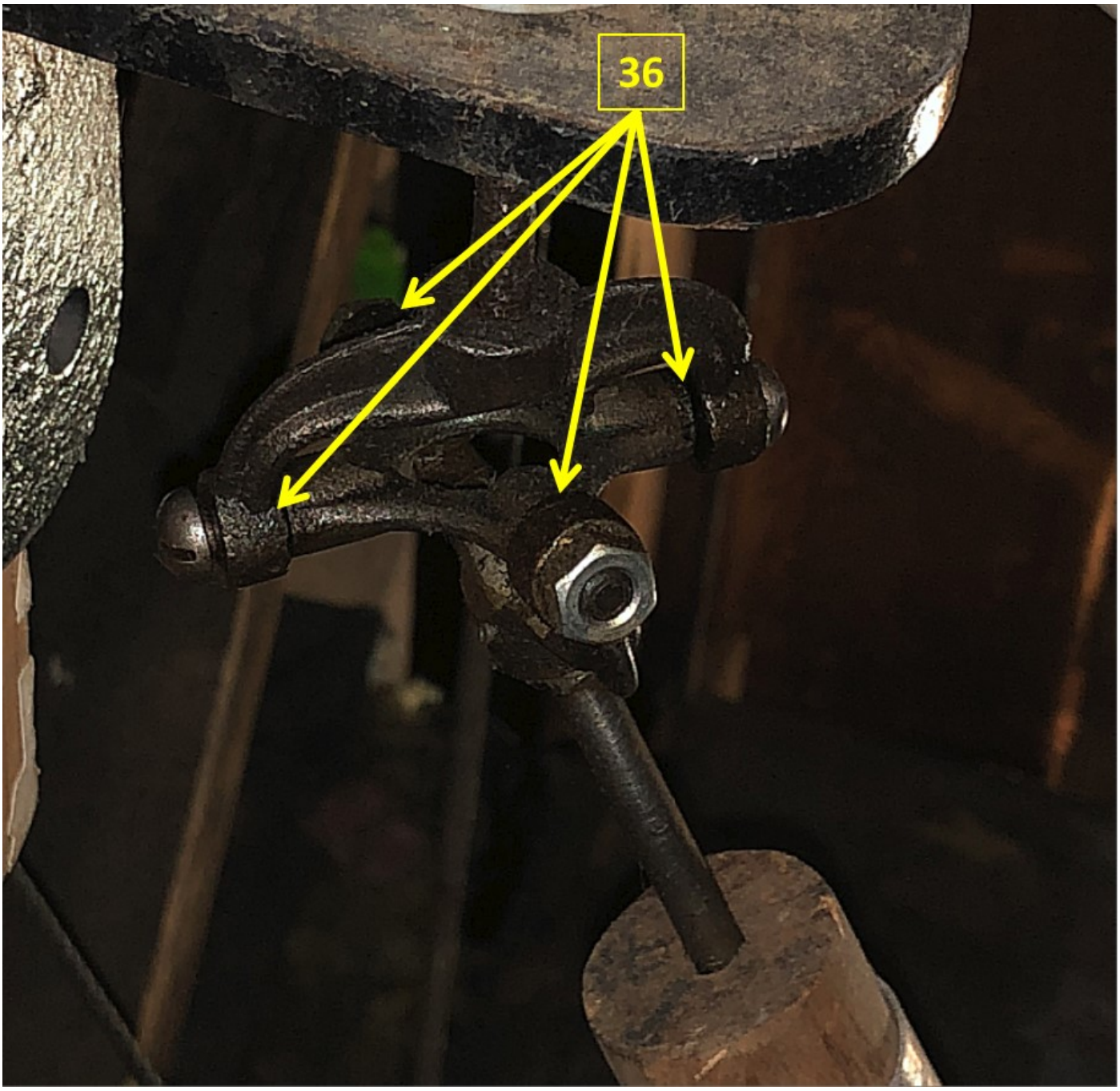


The three universal joints that need to be oiled in this manner are shown on the pages which follow.

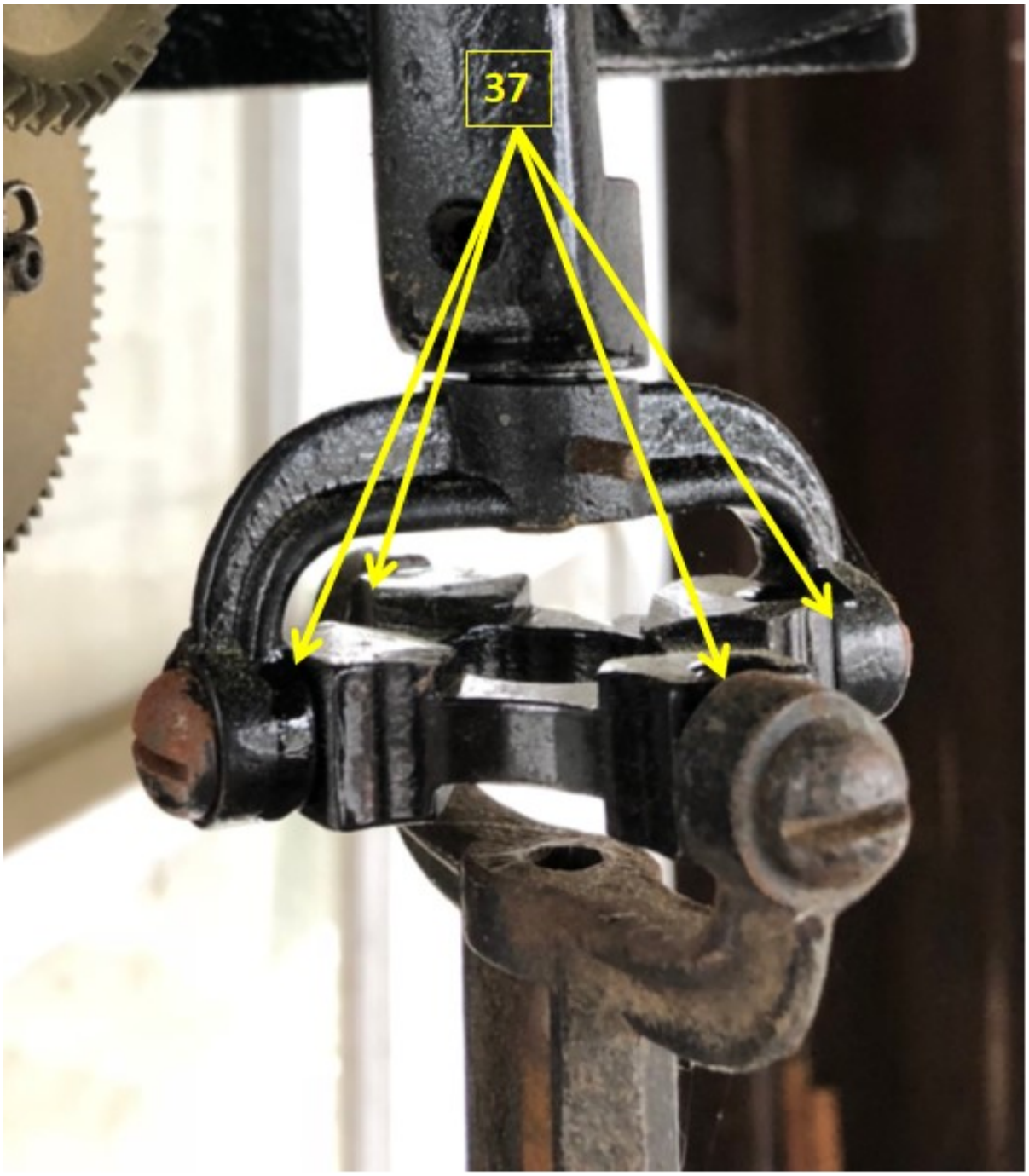
**Universal joint at the top of the clock**



**Universal joint that can be reached from the top of the ladder leading to the belfry**

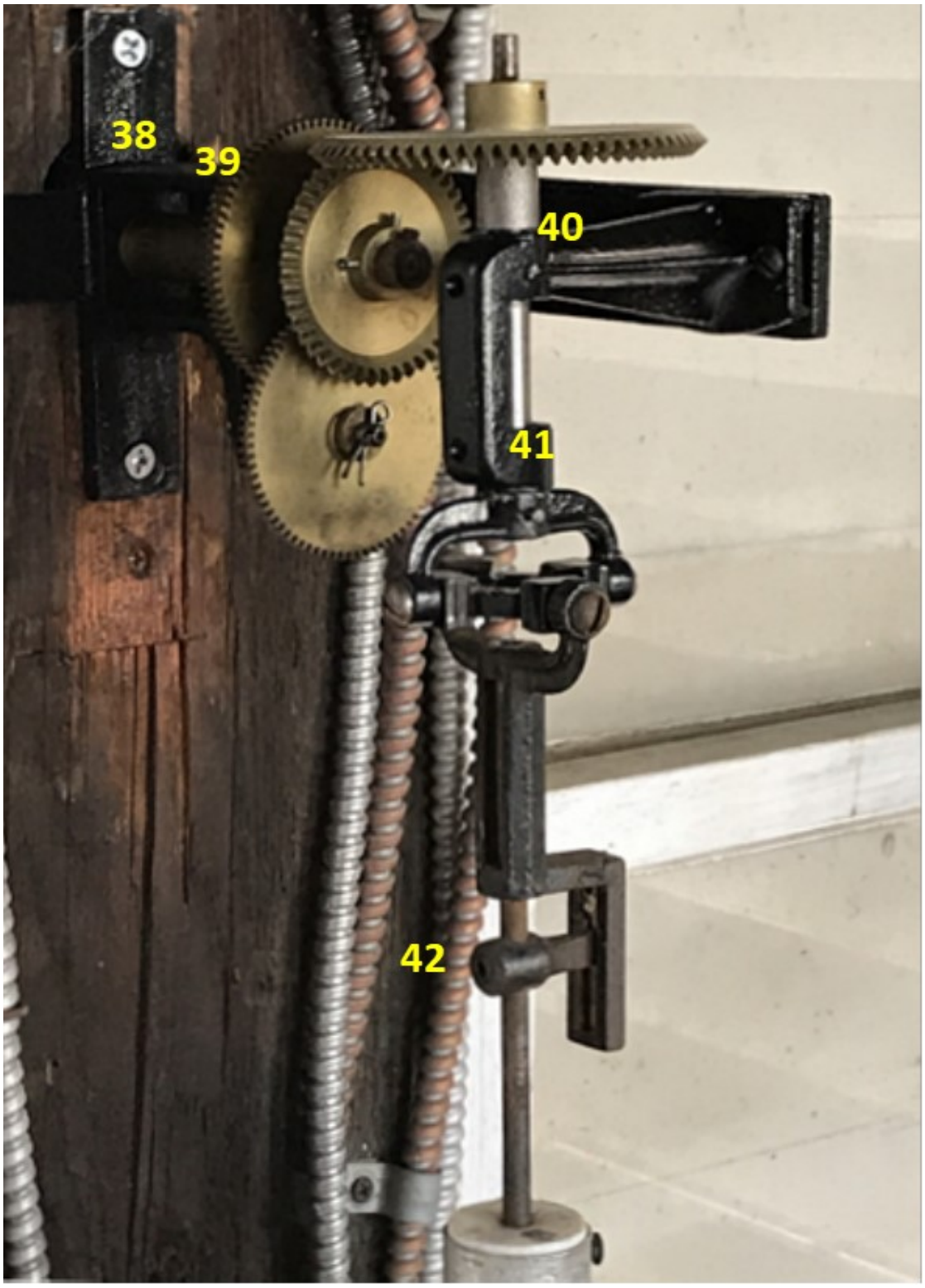


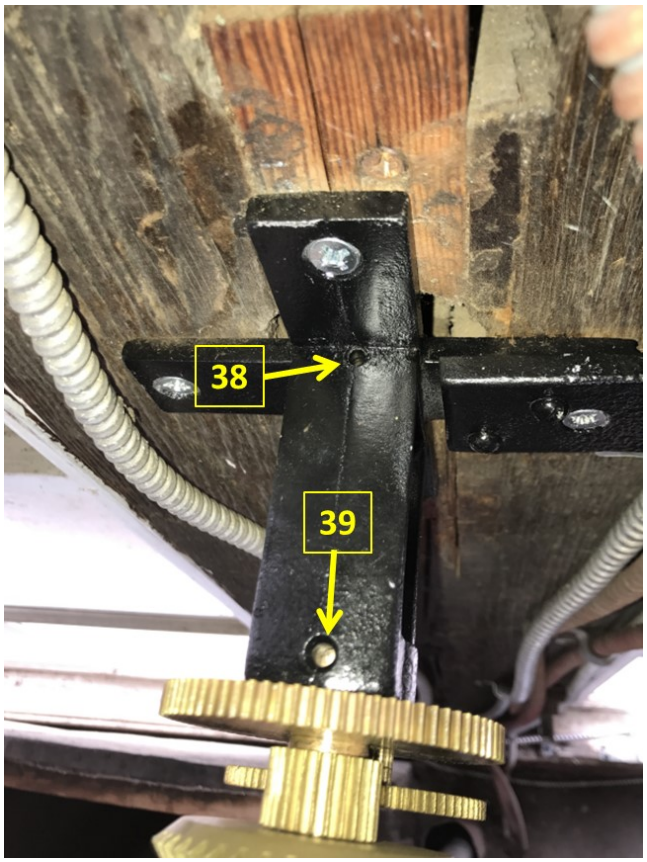
**Universal joint below the motion work in the belfry**

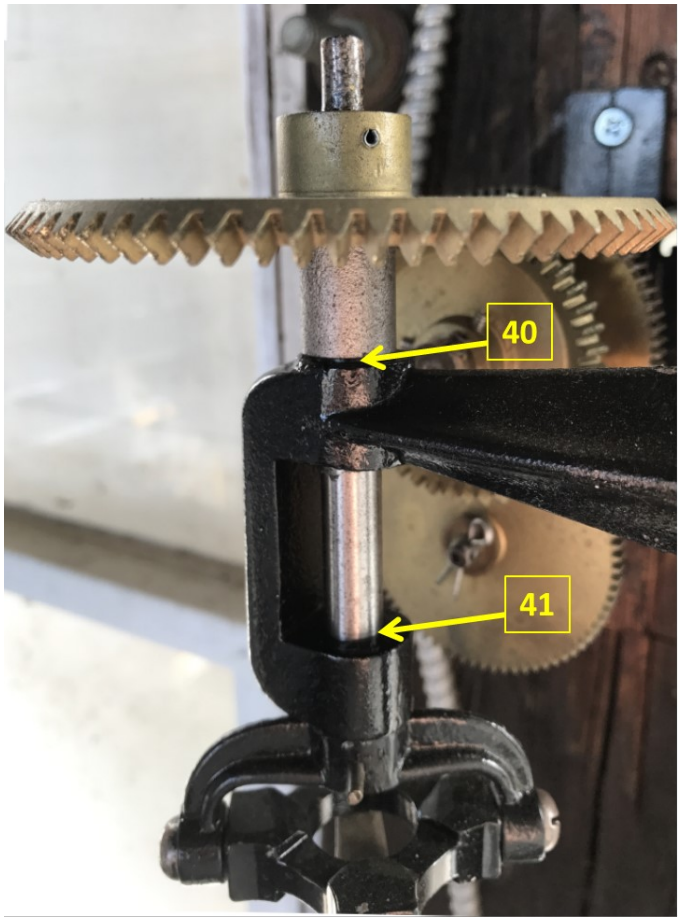


## Oiling the Motion Work and the Bell

The term “motion work” refers to the gearing at the dial that reduces the minute hand rotation 12:1 to the hour hand speed. This gearing is located in the belfry directly behind the clock face. The oiling points are shown below.

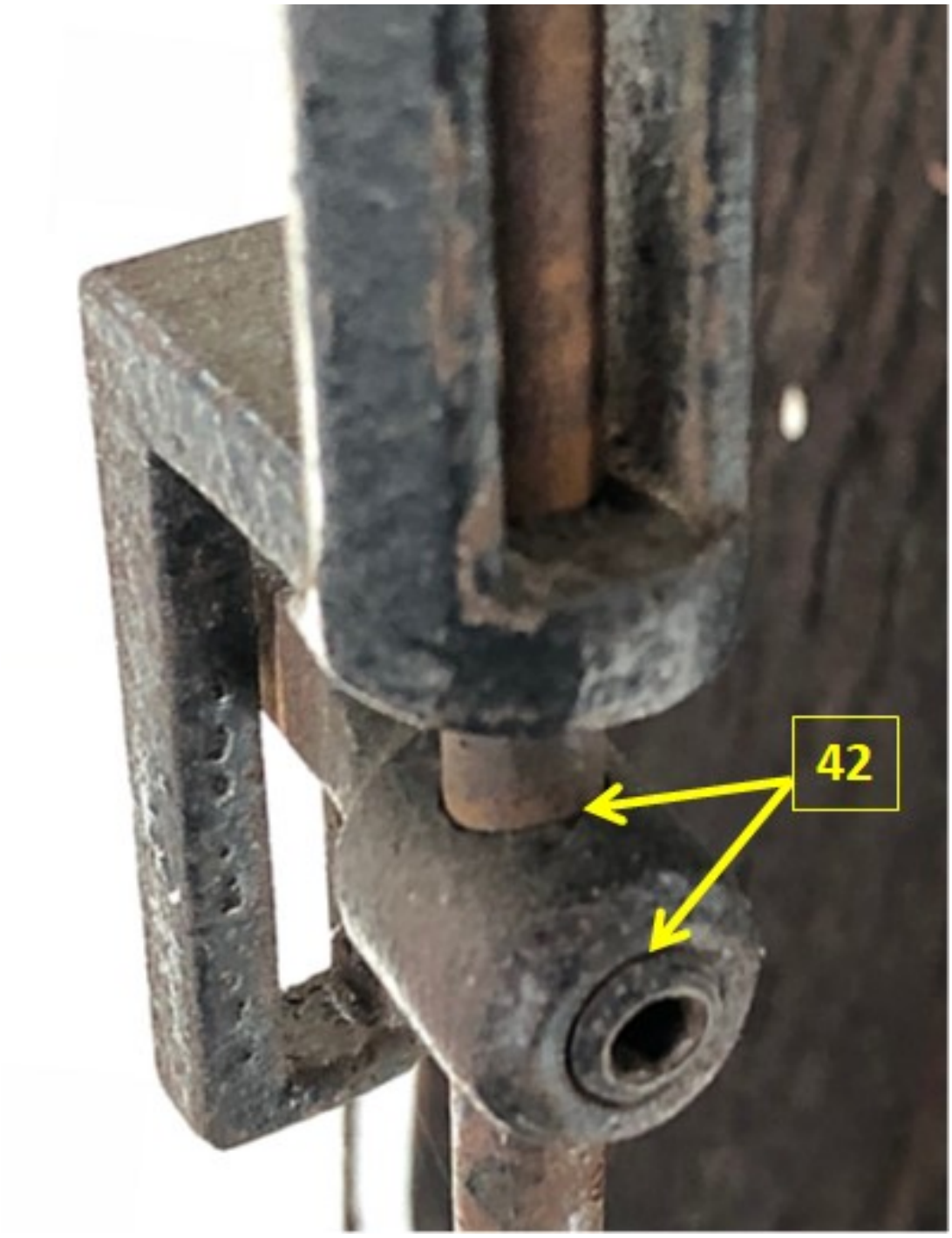





The rod in this section of the motion work extends into the gear above it causing the gear to rotate and turn other gears which ultimately cause the hands of the clock to move. Apply a drop of oil at the two points indicated to keep this rod lubricated.

Though technically not part of the motion work, the photo below shows the set screw which attaches the shaft from the leading-off work to the final universal joint just below the motion work. This set screw must be loosened in order to adjust the hands of the clock without altering the time maintained by the clock engine. Place a drop of oil in the areas indicated to minimize the accumulation of rust and allow the set screw to be turned when needed.



Oil the two points indicated to provide lubrication to the shaft which rotates when the hammer strikes the bell each hour.

# Oiling the Pulleys

The pulleys that guide the cables to the weight shafts should rotate while in use to ease the strain placed on the cable by direction change. A pulley that fails to rotate may eventually cause the cable and the pulley itself to fail. Ideally, all pulleys that guide weight-bearing cables should be lubricated every 90 days. *The pulleys should be visually inspected to ensure that they are rotating freely when the clock is being wound*.

## Original Main Pulleys

The original one-page set of instructions provided by the E. Howard Clock Company (see the inside cover of this manual) contains the following paragraph:

> *"The bearings of the pulley sheaves should be oiled once each three months at least with clock oil. The oil hole for the bearings of the sheaves is in the square end of the pulley pin just outside of the pulley frame and on the upper side of the square. The bearing is hollow and will hold considerable oil. Fill it full."*

As shown in the photos on the following pages, **six** of the pulleys described by that document are still being used to guide the clock's weight bearing cables. While all should all be lubricated every 90 days via the oil hole pointed to by a red arrow, only three of these pulleys can be reached easily:

- The pulley above the weight which drives the clock mechanism (Figure 1);
- The pulley above the weight which drives the striking mechanism (Figure 2);
- The pulley at the top of the striking weight shaft (Figure 3).

Two other pulleys require a ladder to reach them:

- The pulley on the ceiling above the weight which drives the clock mechanism (Figure 4);
- The pulley on the ceiling directly above the striking mechanism (Figure 5).

The sixth pulley can be reached – albeit with difficulty – from the ladder leading up to the belfry (Figure 6).

Figure 1

Figure 2

Figure 3

Figure 4

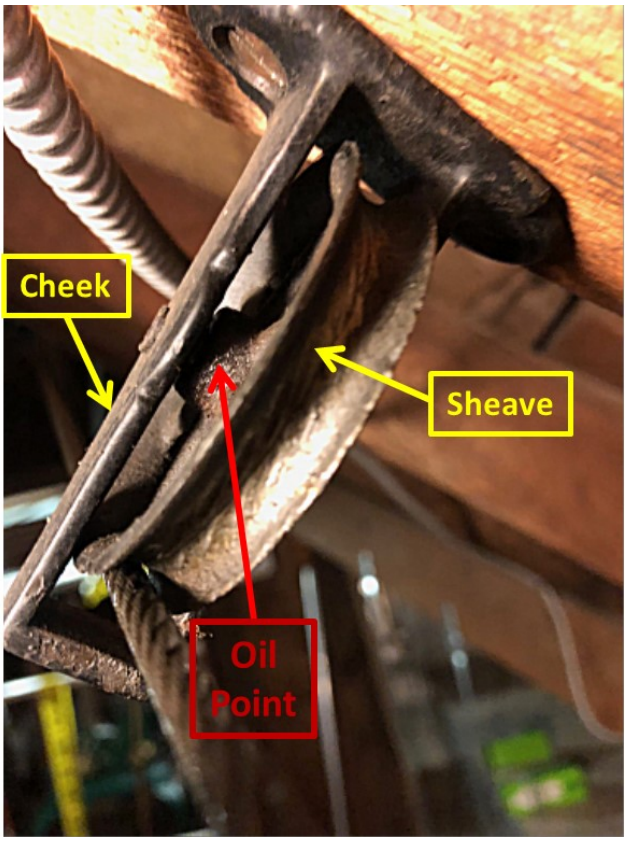
Figure 5

Figure 6

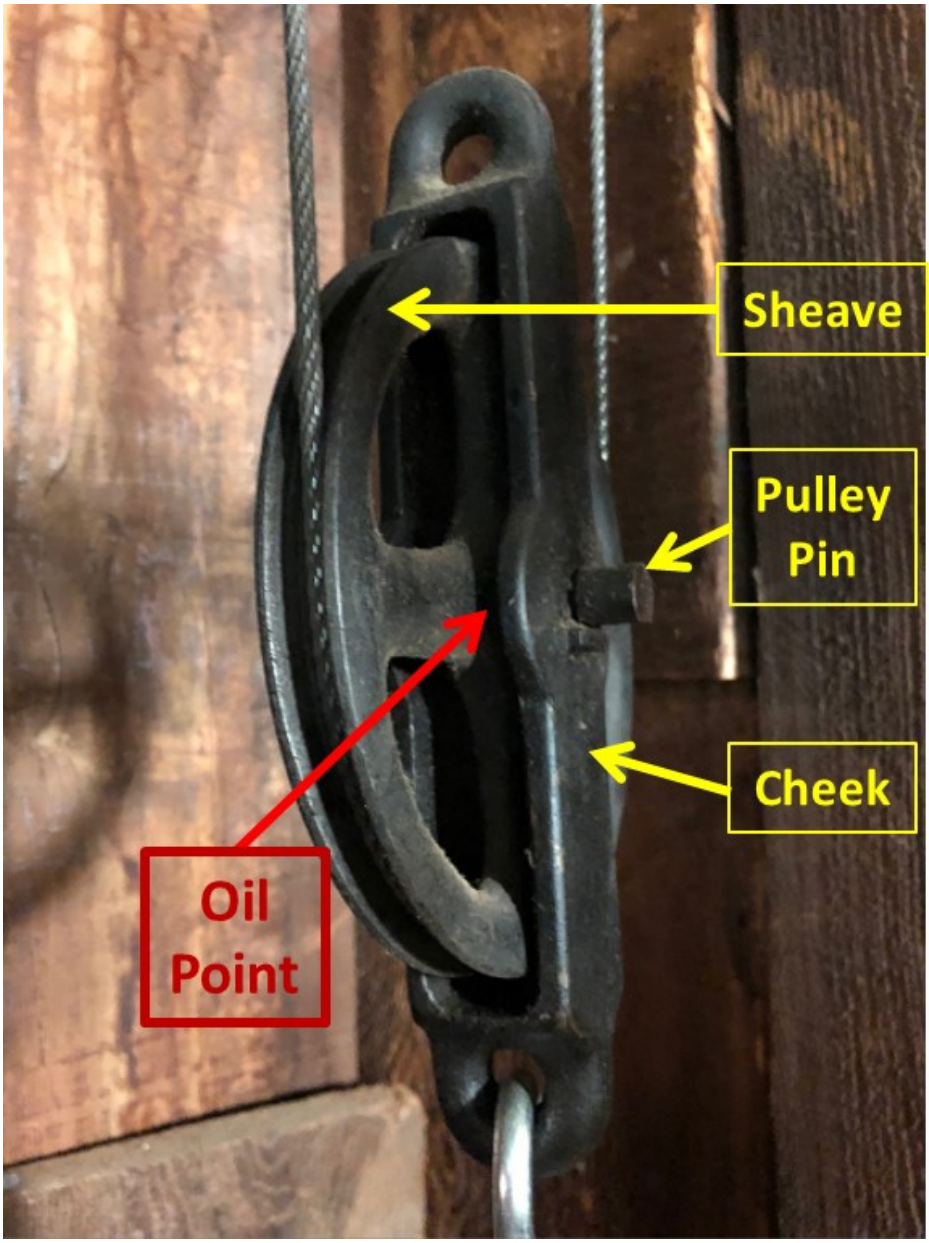
## Guide Pulleys

In addition to the six large pulleys, there are two smaller pulleys that guide the striking weight cable as it runs from the striking weight shaft to the clock, as shown below:

These pulleys do not have an oil hole on the **pulley pin**. They should be lubricated by applying a few drops of oil between the **sheave** and the **cheek** of the pulley, as indicated below.



Note that any of the six large pulleys can also be lubricated in this manner if the oil hole on the pulley pin cannot be reached or is otherwise unusable:



# Greasing

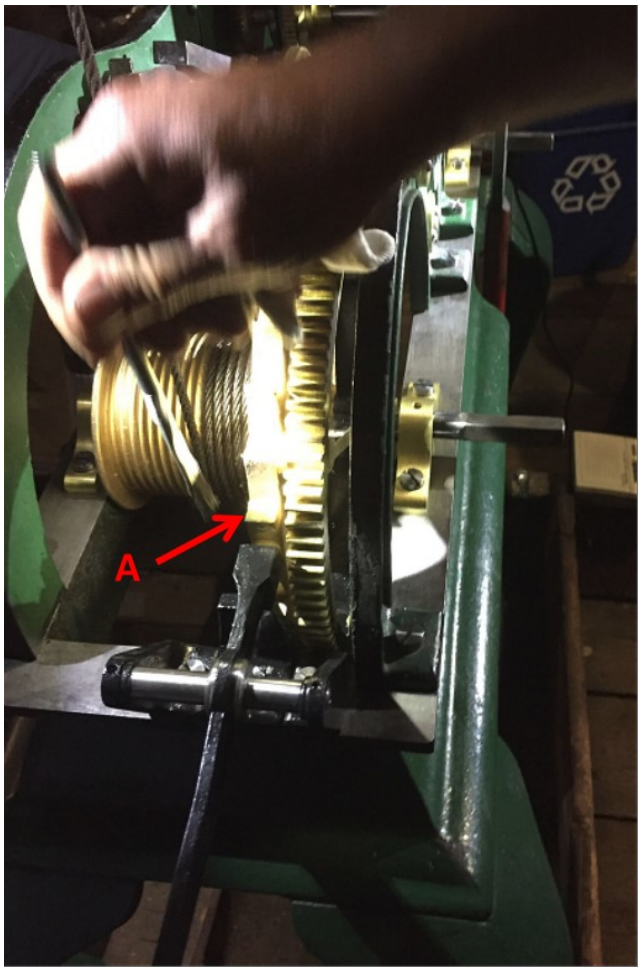
## Overview


There are a few points of the clock mechanism and the bell that should be lightly greased every 90 days. Only the Amalie Blue Hi-Temp grease located in the attic should be used. It should be applied with the grease brush kept in a plastic bag near can of grease. Return the brush to the bag when through greasing.

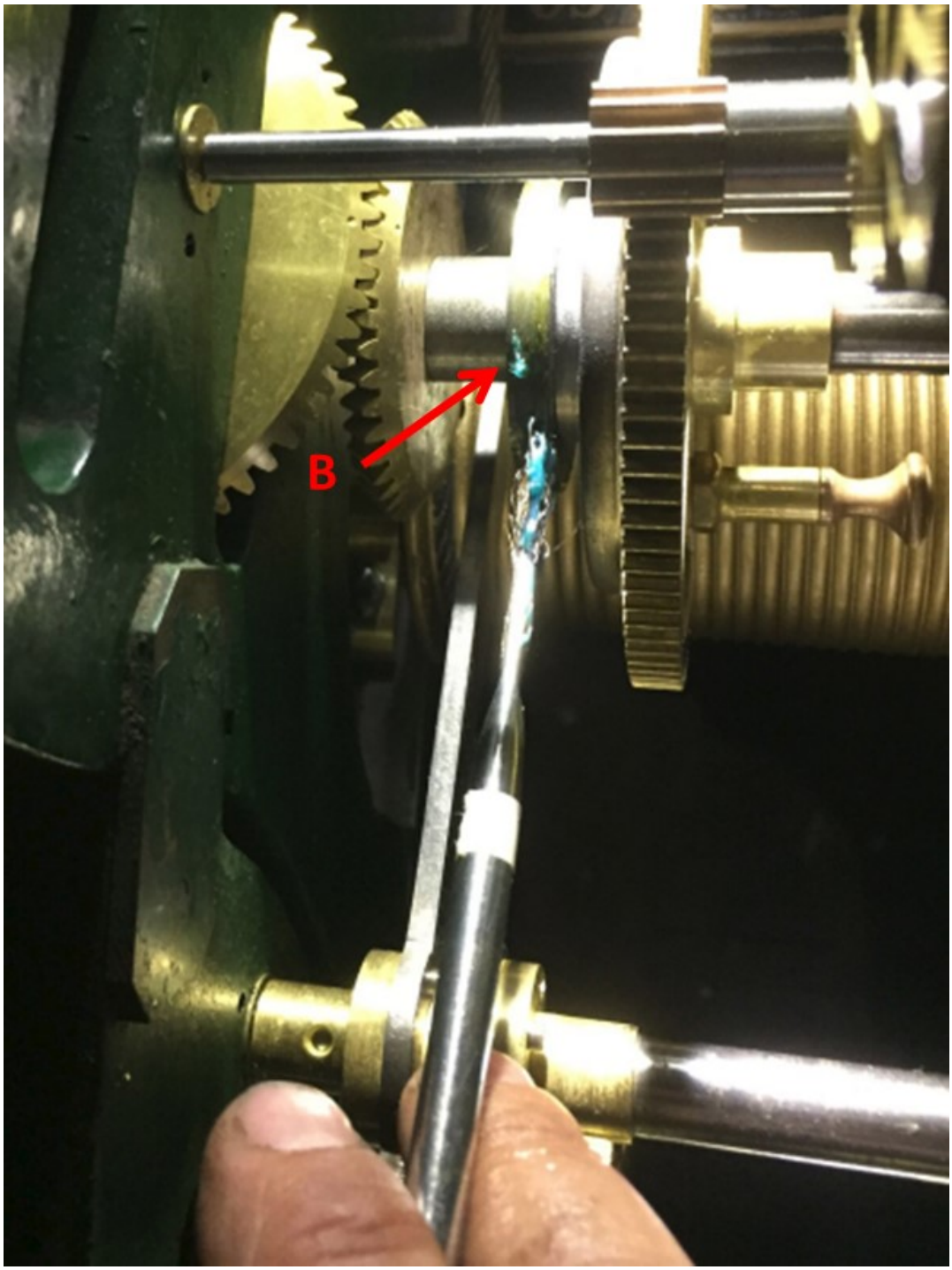
## The Clock

Three points within the clock mechanism need to be greased:

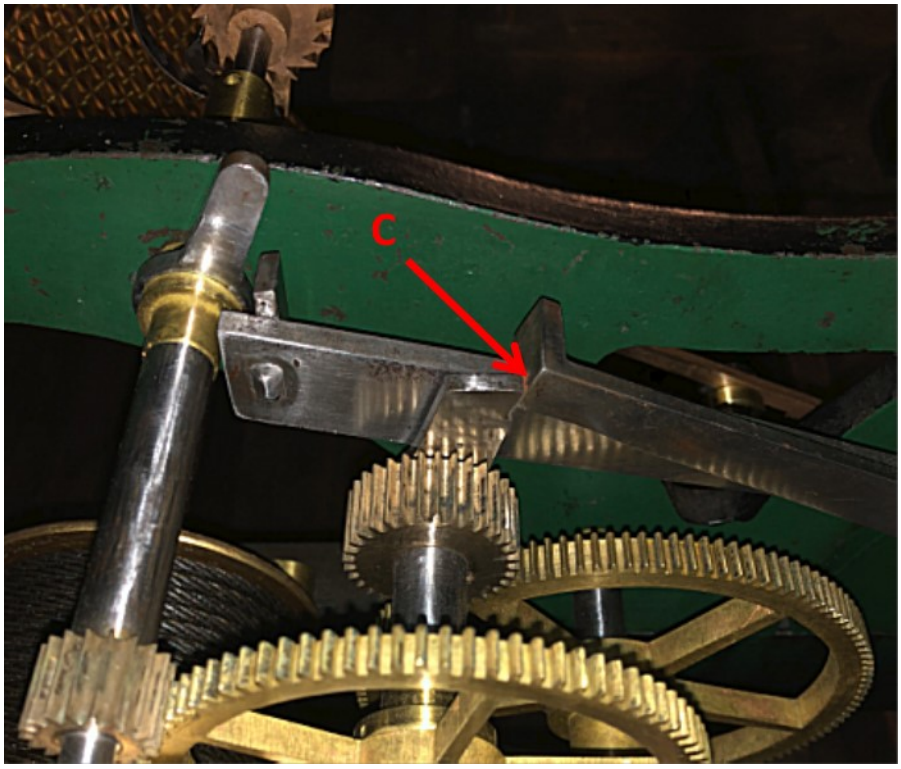
A. The teeth of the **great wheel** of the striking mechanism: This wheel drives the striking of the bell by the hammer in the belfry. It is not necessary to grease all of the gear teeth every 90 days. Just grease the ones that you can reach. Over time all teeth will get the grease they need.

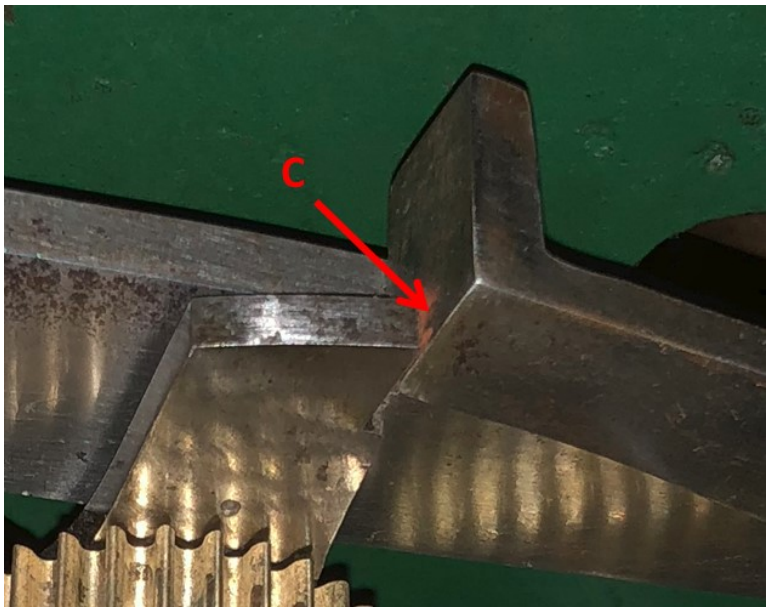


B. <u>The cam wheel on which the lever rides</u>: Hourly chiming is initiated when this lever drops off of the cam allowing the striking weight to rotate the Great Wheel. Apply a thin film of grease on the cam where indicated.



C. <u>The contact point between the lever and the bar it obstructs:</u> The cam slowly raises a lever until a bar that it is obstructing can pass beneath it, causing the clock to **warn**. The area where the two pieces of metal make contact should receive a thin film of grease.



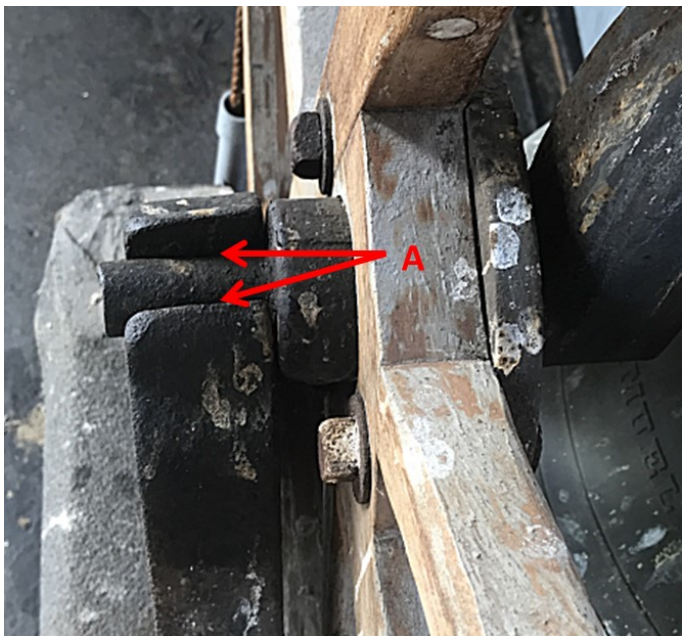



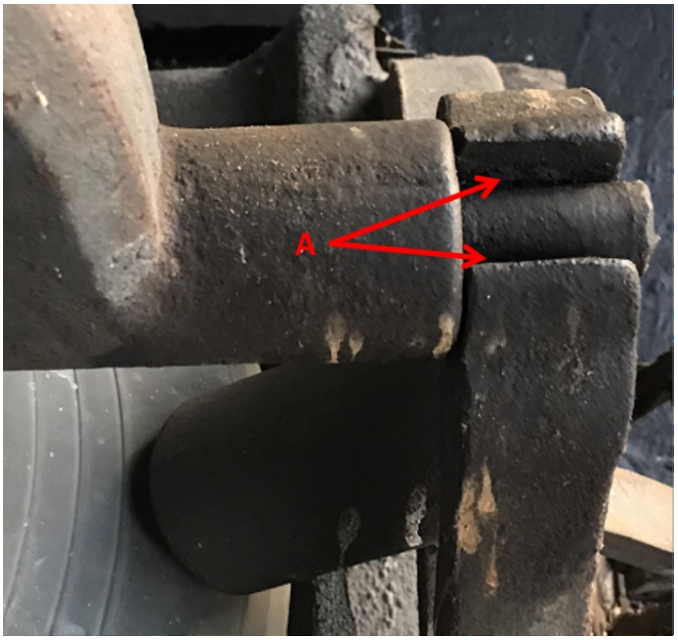

**Close-up of the area to be greased**

## The Bell

At present, the bell in the belfry rings when it is struck by a hammer. Originally, though, the bell was rung by pulling a rope which caused the bell to swing back and forth causing the clapper to strike the sides of the bell. While that capability isn't currently being used, the following points on the bell should be greased as needed to prevent that functionality from being lost:

A. The **trunnions** (or pins): These pins rotate within the yoke frame when the bell swings from side to side. There is one pin on each side of the bell. Put a dab of grease on both sides of each pin as indicated.



B. <u>The clapper pin:</u> The clapper is attached to the bell by a clapper pin which, in turn, is held in place by a cotter pin (which is missing). The clapper pin functions as an axle on which the clapper swings when the bell is pulled by a rope. Grease the clapper pin as needed by sliding it out and removing it from the bell and then re-assembling. This is a two-person job: one person to rotate and hold the bell and another person to disassemble, grease and re-assemble.


**Inside of the bell showing clapper and clapper pin (B)**


**Clapper pin (B) disassembled and greased**

# Remote Monitoring of the Clock


An **Amcrest ProHD 1080P WiFi Camera** is installed in the attic of Town Hall to allow Clockwinders to remotely monitor the status of the tower clock. Some of its key features:

- Wi-Fi connectivity to the Internet providing the ability to view a live stream of the clock at any time using an Amcrest mobile application called **Amcrest View Pro**.
- Ability to pan, tilt and zoom the camera remotely;
- Night vision;
- Local storage of all motion detection events, videos, and snapshots via an onboard 64GB MicroSD card;
- Ability to view all motion detection events within the last 4 hours on an Amcrest cloud server;
- Email notification from Amcrest of all motion detection events sent to the cloud.

### Amcrest View Pro

Amcrest provides a number of tools to configure and use the camera. Of particular importance to Clockwinders is their **View Pro** application. Currently, it runs on only an IOS or Android platform and provides a live audio/video feed of the clock. Here's how to install this application on your mobile device:

#### Installing on an iPhone or Android Phone

1. Download and open an app called **Amcrest View Pro**.
2. Click "Don't Allow" to the message: "*Amcrest View would like to Add to your Photos*"
3. Click "Don't Allow" to the message: "*Amcrest View would like to send you notifications*"
4. Click "Start" to the message: "*Welcome to Amcrest View*". You may be given a brief tutorial on the app. If not, you can always run the tutorial from the Help option on the Main Menu.
5. Select "Device Manager" from the Main Menu
6. Click on "Add Device"
7. Click on "WiFi Camera"

8. Click on "*Add an already connected camera*"
9. Click on P2P Setup
10. Click "Don't Allow" to the message: "*Amcrest View would like to access the camera*".
11. Click on "Enter S/N Manually"; then enter AMC000615072FE170D
12. A Camera Login screen will appear:
    1. Give your device manager any name you want
    2. Leave **Username** as “admin”
    3. Change **Password** to “<redacted>”
    4. Click on "Start Live View". If a live video feed does not appear automatically:
        - Click on the camera menu icon in upper right corner of the screen.
        - Click on your device name
        - Click on the “IPC” row
        - Click on “Start Live View”

## Installing on an iPad or Android Tablet

1. Download and open an app called **Amcrest View Pro for iPad/Android**.
2. Click on "Don't Allow" to the message "*Amcrest View Pro would like to Send You Notifications*".
3. You may be given a brief tutorial on the app. If not, you can always run the tutorial from the Help option on the Main Menu.
4. The upper left corner of the screen has a Menu icon -- it looks like three lines with a dot in front of each line. Click on it. A list of actions will be displayed.
5. Click on "Device Manager".
6. Click on "Add Device";
7. Under the “Type” column, click on P2P
8. Click on the far right side of the "Name:" row. Give your device manager any name you want.
9. Click on the "S/N:" row and enter the following serial number: AMC000615072FE170D
10. Leave the **Username** row alone. It should have a value of "admin"
11. Click on the **Password** row. Enter a value of "<redacted>";
12. Click on the **Live View** row; a new screen will appear. Click on "Main";
13. Click on the **Playback** row; a new screen will appear. Click on "Main";
14. Click on the button at the bottom of the screen labeled "Start Live View". If a live video feed does not appear automatically:

- Click on the camera menu icon in upper right corner of the screen.
- Click on your device name, the “IPC” row, and “Start Live View”.

## Using the View Pro application

If you've done everything correctly you should be receiving a live video feed from the Town Hall attic. Play around with the application until you are comfortable with it. Do not change any passwords or user ID’s though, since that would lock out everyone else on the Clock Winding Committee. The camera can always be returned to its factory settings, though, so no worries if you screw something up. Here are how to perform a few basic, everyday tasks:

- **View a live video stream of the clock**
    - Open the app and click on the Menu option called "Live View". If a live video feed does not appear automatically:
        - Click on the camera menu icon in upper right corner of the screen.
        - Click on your device name
        - Click on the “IPC” row
        - Click on “Start Live View”
    - It's usually best to view the clock in landscape mode.
    - Tap the screen to view a set of actions that can be taken from this screen.
    - Click the camera icon to take a snapshot of the screen.
    - Click the video camera icon to start/stop a recording of what's on the screen.
    - Click the speaker icon to hear the clock ticking or chiming.
    - Click the microphone icon to talk to someone in the attic.
    - Click the circular icon containing arrows to control the camera's Pan/Tilt/Zoom options:
        - Swipe left or right to pan the camera;
        - Swipe up or down to tilt the camera up or down;
        - Pinch/unPinch to Zoom/Unzoom the camera;

Before leaving Live View, make sure the clock is centered and fills the screen from top to bottom as much as possible. This will ensure that motion-detection works properly.

- **View motion-detection events from the past**
    - Open the app and click on the Menu option called "Playback".
    - Click on the "+" symbol in any of the 4 quadrants:
        - Set the date and time range for the events you wish to view;
        - Click on the name that you've assigned to your device;
        - Click on "IPC";
    - Recorded videos captured during that date and time range will play in the quadrant selected.
        - Double-click on the quadrant to change it to full screen; rotate your phone to view in landscape mode.
        - Tap on the screen to see actions that can be taken during playback:
            - Click the speaker icon at the bottom of the screen to toggle audio on/off;
            - Click the camera or video camera icons to take pictures or videos of anything being viewed.
            - Slide the time-range bar to the left or right if you want to select a specific time period within your time range;
            - Click on the icon on the far right to end your Playback session.

- **View Saved Files**

  In addition to viewing motion-detection events that are automatically captured, you can also view pictures and videos that have been taken manually during "Live View" or "Playback" sessions and stored local on the 64GB MicroSD card:

    - Click on the Menu option called "My Saved Files"; a screen with two icons in the top center will be displayed.
    - Click on the icon on the left to view saved videos; click on the icon on the right to view saved photos.
    - Click on the pencil icon to the far right. This will allow you to select one or more photos or videos by tapping on them. Three icons will be displayed at the bottom of the screen. Click on the first icon to email the selected photos/videos or click on the trash can icon to delete them.

## Motion-Detection Email Alerts

As mentioned earlier, videos of **all** motion-detection events are stored on the camera. The **last 4 hours** of motion-detection events are also stored on an Amcrest cloud server. Most important, whenever a motion-detection event is captured on the Amcrest cloud server, an email alert is sent to a user-specified email account. A general-purpose Clockwinders Gmail account was created to receive all of these alerts. It can be accessed by logging into Gmail with the following credentials:

Account Name: cranburyclock@gmail.com
Password: <redacted>

To access this account through your iPhone (highly recommended!), do the following:

1. From the Home screen, click on "Settings"
2. Click on "Accounts and Passwords"
3. Scroll to the bottom and click on "Add Account"
4. Click on "Google"
5. In the "Email or phone" field enter **cranburyclock** and click on "Next"
6. In the "Password" field enter **<redacted>**

If operating properly, the Amcrest Cloud Notification Service will send two emails to this account every hour:

1. When the clock strikes at the top of the hour;
2. When the striking mechanism **warns** at about 35 minutes after the hour.

Occasionally, the motion of the clock at 35 minutes after the hour will not be detected, but all motion events at the top of each hour should be detected. If one of those emails is missing, it might point to a problem.

Note that the time stamp on the motion alert at the top of the hour (when the clock strikes) will indicate how accurately the clock is keeping time.

Since almost 300 emails will be generated each week, it's recommended that all alert messages be deleted every few days. If there is an alert message that needs to be saved, move it to a folder called "Saved Motion Alerts".

# Glossary

**Anchor**: Part of the escapement (shaped a bit like a ship's anchor) that swings back and forth on a pivot above the escape wheel; pallets on either end of the anchor alternately engage the teeth on the escape wheel, causing the clock's ticking sound.

**Arbor**: A rotating shaft or axle within the clock mechanism; also known as a spindle.

**Backlash**: Lost motion in a mechanism caused by the gaps between its component parts. In the case of a tower clock, it refers to the lost motion caused by gaps or looseness in the clock's leading off work and motion work, i.e., the gears, drive shafts and universal joints that lie between the clock engine and the hands of the clock.

**Barrel**: See Drum

**Belfry**: Location above the attic where the bell is hung.

**Bushing**: A brass bearing that is used to create a hole in the clock frame to hold a pivot.

**Cable**: Multiple strands of steel wire twisted together to form a wire rope; used to provide support for the weights that drive the clock mechanism and the striking mechanism.

**Cam**: An eccentric wheel on an arbor that rotates once every hour to gradually raise a lever that drops exactly on the hour to start the striking process.

**Cheek**: The outer faces of the pulley which hold the pulley pin (or arbor) on which the grooved wheel rotates.

**Chiming**: Often used interchangeably with striking but technically refers to the sounding of one or more bells at each quarter of the hour, something that the striking mechanism of our clock is not equipped to do

**Click**: Device to stop a wheel from turning backwards; also called a pawl

**Clock mechanism**: The section of the clock that controls the movement of the hands on the dial

**Clock plate**: The walls of the clock mechanism that hold the arbors in place

**Crank**: A tool used to manually wind the time drum and the striking drum by attaching it to the end of an arbor protruding from each drum.

**Crankshaft**: An arbor on a tower clock that can be fitted with a crank in order to wind either the time drum or the striking drum.

**Crutch**: A lever that, via the crutch pin, transfers energy from the escapement to the pendulum.

**Crutch pin**: A metallic pin on the end of the crutch which extends through a slot in the pendulum; it transfers energy from the escapement to the pendulum by giving the pendulum a slight push each swing.

**Deadbeat escapement**: The type of escapement used by our E. Howard Clock; an escapement that does not recoil, also known as the Graham deadbeat escapement.

**Dial**: The face of the clock; the external dial containing the actual hands of the clock.

**Drum**: Cylinder or barrel around which a weight cable is wound. There are two drums in our clock: the time drum and the striking drum.

**Dust cover**: A series of acrylic sheets suspended above the clock in the attic of Town Hall to protect it from dirt and debris falling from the rafters

**Escapement**: A component of the clock mechanism (consisting of an escape wheel and an anchor) that maintains the swing of the pendulum and allows the clock's gears to advance a fixed amount, moving the clock's hands forward.

**Escape wheel**: A gear within the escapement which allows the clock's gear train to advance or "escape" by a fixed amount and move the clock's hands forward; The teeth of the escape wheel also transmit energy to the pendulum to keep it swinging. The sudden stop of a tooth against the escapement's pallet generates the ticking sound of the clock.

**Fly fan**: A device which dampens the speed with which the clock strikes

**Going train**: Series of gears that drive the dial; see Clock mechanism

**Great wheel**: The first wheel on the gear train; it is not fixed to the winding drum, but rides loosely on the drum arbor. A click on the wheel works on ratchet teeth cut on the

drum, thereby allowing the drum to turn the wheel and the gear train while the clock is operating normally.

**Horology**: The scientific study of time; the measurement of time and the making of clocks

**Impulse face**: The part of the escapement pallet that transfers power to the pendulum to keep it moving.

**Leading off rod**: A rod (or tube) which is used in the leading off work to transfer rotational power from the clock to the motion work

**Leading off work**: Collection of rods, gears and universal joints that connect the clock to the motion work

**Motion work**: Reduction gears behind the dial which drive the hour hand from the minute hand.

**Oil sink:** A slight depression in a bushing that helps to keep as much oil as possible around the pivots without runoff.

**Pallets:** Component parts of the escapement; specifically, the metal tabs located at the end of each arm of the anchor which alternately engage the teeth on the escape wheel.

**Pawl:** See Click

**Pinion**: A small gear of 10 teeth (leaves) or less that is driven by a larger gear.

**Pivot**: The thin end of an arbor which rests in the bearing and holds gears in place as they rotate. It is usually made of steel and highly polished to reduce friction

**Pulley**: A simple machine consisting of a wheel on an axle over which a pulled cable runs to lift the weights used to run the clock mechanism and the striking mechanism of the clock. See Sheave.

**Rack**: A component of the striking mechanism that controls the number of times the bell is struck each hour. Each notch on the rack corresponds to one bell strike.

**Ratchet**: Gear wheel with saw-like teeth arrested by a click.

**Regulate**: Speeding up or slowing down the clock mechanism by adjusting the length of the pendulum

**Regulator knob**: A round gold-colored dial at the top of the pendulum that can be turned clockwise or counter-clockwise to change the effective length of the pendulum, thus altering the speed of the clock

**Setting dial**: An internal dial mounted on the clock mechanism which, when turned, rotates the hands of the external dial.

**Setting pin**: A spring-loaded pin which goes through the center wheel and into a hole in a plate containing 60 holes (one for each minute)

**Sheave**: A pulley with a grooved wheel for holding a belt, wire rope, or rope. The grooved wheel spins on an axle inside the frame of the pulley. This allows the wire or rope to move freely, minimizing friction and wear on the cable.

**Snail**: A cam which resides on an axle that rotates once every 12 hours. It controls how much of the rack is exposed and thus how many strikes of the bell will occur each hour. The highest shelf of the snail allows only 1 strike of the bell while the deepest shelf allows 12 strikes.

**Striking**: The sounding of the bell at each hour.

**Striking drum**: Cylinder around which a weight cable is wound to power the striking mechanism. The striking drum should be wound counter-clockwise.

**Striking mechanism**: The section of the clock that controls the number of times the bell is struck on the hour; it consists of a train of wheels, a fan fly regulator, its own set of hanging weights, and a hammer which strikes the bell.

**Striking weight**: Weight hung at the end of a steel cable which power to the striking mechanism.

**Striking weight shaft**: A narrow rectangular hole that runs from the attic to the bottom of the 2$^{nd}$ floor of Town Hall and houses the weight which drives the striking mechanism. When necessary, the striking weight can be accessed by removing a section of baseboard at the bottom of this shaft.

**Time drum**: Cylinder around which a weight cable is wound to power the clock mechanism. The time drum should be wound clockwise.

**Time weight**: Weight hung at the end of a steel cable which power to the clock mechanism.

**Trunnion**: one of two metal pins (cylindrical protrusions) used to mount the bell on its stand; the trunnions also function as a pivoting point when the bell is rung by pulling on a rope.

**Turret Clock**: British term for Tower Clock

**Universal joint**: A joint or coupling that allows the transfer of power or motion between two or more rods that are at angles to one another.

**Warning**: The short release and arrest of the strike train a few minutes before the actual strike; in the case of our clock, this occurs at approximately 35 minutes after the hour. Once the clock has warned, the strike train should not be wound until after the hourly strike.