Burnishing

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Why Burnish?

Burnishing is a polishing and work hardening of a metallic surface. This process will smooth and harden the surface, creating a finish which will last longer than one that hasn't been burnished. This is a desirable characteristic in clockmaking and watchmaking since the major determining factor in how long a clock or watch will run is the degree to which the bearings will wear over time. Long-lasting bearing surfaces, like pivots and pivot holes, will greatly increase the length of time that a clock or watch will perform as expected. Although this article is primarily targeting the burnishing process for clocks, the same methods may be applied to watches with the understanding that jewel holes need not, nor can they be, burnished.

Why Not Burnish?

Modern German movements use plated steels which do not react well to the burnishing process. The pivots in these movements are very soft and it is only the plating that keeps them from wearing out immediately. Once the plating is gone, the only choice is to replace the pivot or replace the whole movement.

These pivots can be polished but the plating is easily damaged. It can come off as a cylinder, after breaking loose at the shoulder, during the polishing process (fig 1). To polish these, it is best to use the square edge of a piece of soft wood, (like the handle of a buff stick) charged with Simichrome[1]. The soft wood won't damage the plating and the Simichrome is a mild enough abrasive that very little of the plating is removed (fig 2).

Fig. 1-Burnishing a plated pivot will cause the plating to flake, as shown here. The plating can be seen as particulates in the oil on the burnisher.

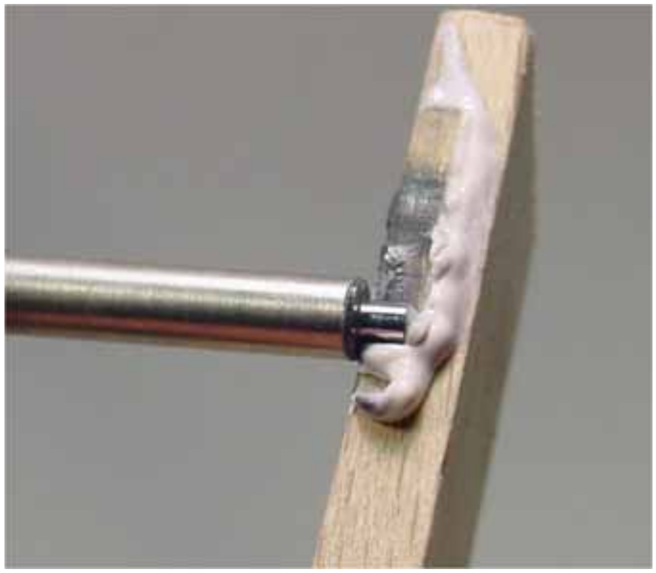


Fig. 2-Plated pivots, in which the plating is still good, can be safely polished with the edge of a buff stick[1] charged with Simichrome[1]. Once the plating is gone however, the finish on the pivot won't last long regardless of how well it is polished.

So, these pivots can be carefully polished but they cannot be burnished. The burnishing process will cause the thin plating to craze and crack. It may not be visible at the time, but after about a month's run, the plating lets go, mixes with the oils or grease, and forms a black ooze.

Burnishing involves applying pressure against the surface of the pivot, stretching and work hardening it. The hard surface of the plating has no support and is easily damaged in the process. It is like a chocolate covered ice cream bar; thin, hard outside layer covering a soft interior.

Polishing vs. Burnishing

Even though polishing occurs as a result of burnishing, polishing in itself is not burnishing. The distinction is that polishing will produce a smooth finish, but not a hard one. Polishing is more about removing material to obtain the desired finish where as burnishing is a stretching and hardening with minimal material loss.

It is impossible to tell by looking at a pivot whether it has been polished or burnished but burnishing will generally result in a deeper polish than is possible with polishing alone. A hardness or wear test would be necessary to distinguish between them.

It will be necessary to use magnification when polishing in order to see the fine details of the surface being polished. In addition, **it is very important to wear eye protection when polishing or burnishing**.

Polishing is an important first step in the burnishing process and a test of the craftsman's ability to bring a pivot to the point it can be burnished. A poor polish will make it very difficult to bring the pivot to perfection with burnishing alone. For example, it would take a very long time to burnish a groove out of a pivot where a mere touch of the pivot file will remove the groove very quickly.

Polishing can be done with any kind of abrasive or cutting tool (figs 3 & 4). Files, sandpaper, or stones are common polishing agents and are less expensive than other polishing methods. Polishing powders and diamond compounds can be used for polishing but this can introduce the risk of embedding the polishing material in the piece being polished. A movement with pivots that have become charged with a diamond compound, for example, will become unreliable rather quickly.

Fig. 3-An assortment of stones used for polishing.

Fig. 4-An assortment of polishing aids includes buff sticks[1], Craytex[2], Simichrome[1], and files.

Polishing With a Pivot File: As has already been mentioned, polishing is a necessary first step in the burnishing process. One method of polishing is to use a pivot file. These come in both right- and left-hand versions, like burnishers, and the correct shape must be selected for the method of use (see "Types of Burnishers").

The cut of a pivot file is very fine, yet with the proper technique, it will quickly reduce the steel of a pivot and leave a fine grain that is easily burnished. On hard steels it may be necessary to allow the pivot file to load up or "stay dirty." This method uses the steel shavings on the file to cut the hard steel of the pivot. On soft steels however, it is necessary to keep the pivot file clean so the shavings don't score the finish. A suitable pre-burnishing polish can be attained by varying the pressure of the pivot file against the pivot, feeling the file cut the steel, and watching the finish progress under magnification.

Practice and experience make this process go very quickly which, in turn, allows the burnishing process to go quickly as well.

The Shape of a Pivot: It is important to pay attention to the shape of the pivot during the polishing process. One of the most difficult tasks is to keep a pivot flat when the pivot surface has extreme wear. Without careful hand control, the pivot will end up tapered (fig 5) or barrel shaped (fig 6). Avoiding this requires a sharp eye and expert hand control in order to work the high point of a pivot until it is flat. Once a flat area has been produced, it will take more hand control to be able to extend that area until the whole pivot is flat. A tapered or barrel shaped pivot will not have sufficient bearing surface to be wear resistant, since it will contact the pivot hole in a very small area.


Fig. 5-Two tapered pivots. The pivot on the left is obviously tapered towards the shoulder but the one on the right has a less obvious taper.

Although not normally desirable, pivots are sometimes given a barrel shape on purpose. In cuckoo clocks, for example, it is advantageous to have barrel shaped pivots due to the flexure of the movement and the way it is mounted. Cuckoo movements are supported from the front plate with no support underneath. When the weights are attached, the movement flexes at the pillar posts causing a slight miss-alignment in the pivot holes. This would cause a bind if the pivots were flat but not if they were barrel shaped.

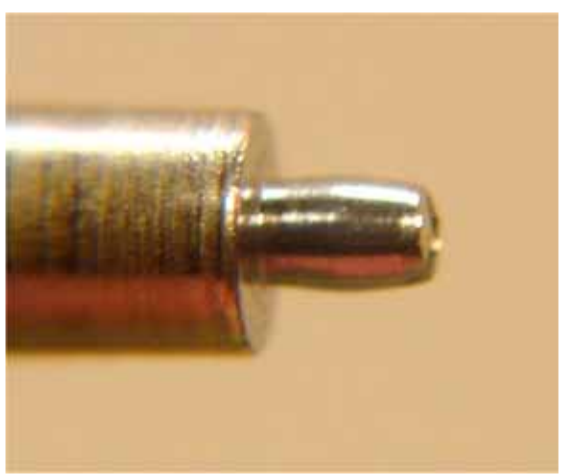
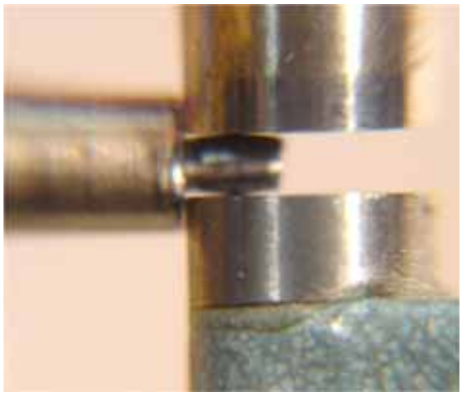


Fig. 6-Barrel shaped pivots are usually a result of poor technique. But this is sometimes done on purpose for specific movements.

One way to test the shape of a pivot to see if it is flat, tapered, or barrel shaped is to use a micrometer and look for light between the spindle and anvil when closed on the pivot (fig 7). It will be much easier to see a polishing problem and to make hand pressure adjustments using this method. If the craftsman has a tendency to consistently taper a pivot so it is narrow toward the shoulder, a conscious effort to apply more pressure with the pivot file on the outer end of the pivot should solve the problem.



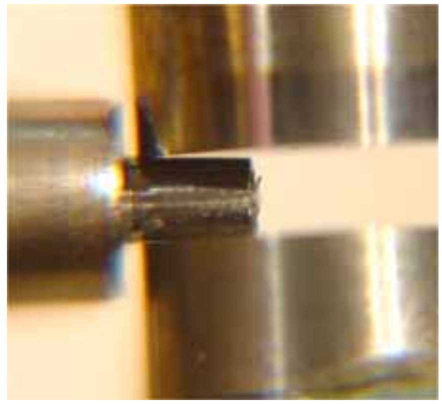


Fig. 7-Until the eye can be trained to see subtle tapers, it is advantageous to use references as an aid. Here, a micrometer is used to help visualize problem pivot shapes. The barrel shape of the pivot on the left is obvious. But the taper in the pivot on the right is more difficult to see without an aid.

Burnisher Lubrication

When using a burnisher or smooth broach it is important to apply a lubricant. There are many choices, some better than others, but following a few guidelines will make the choice of which to use easier.

Contamination should always be a consideration. When burnishing, it is possible the lubrication may be forced into the material and react adversely with the oils used to lubricate the clock. This “impregnation” is more likely to occur when burnishing brass than it is when burnishing steel since brass is softer and more porous. For that reason, it is advisable to lubricate a smooth broach with the same oil that will be used in the clock when burnishing pivot holes. When burnishing pivots however, the choices of lubrication are much broader.

Here are a few guidelines when choosing a proper lubricant for burnishing pivots…

--It should be easily removed without leaving a residue; a lubricant that isn’t easy to remove can be a source of contamination.

--It should be able to hold particulates away from the work. If the lubricant doesn't draw small particulates into itself, the particulates will collect where the burnisher meets the surface of the steel. This will cause the particulates to become an abrasive which will mar the finish and negate the burnishing process.

--It must not evaporate when heated. The burnishing process will generate a small amount of heat at the point where the burnisher meets the metal. If the lubricant has a tendency to evaporate under heat, the effect will be the same as if no lubricant was used.

--It should be inexpensive and easy to find. Burnishing a pivot doesn't require a great amount of lubrication, but burnishing the pivots on two or three clocks per day could. A costly or difficult to find lubrication could introduce a tendency to conserve in a process where too little or too dirty lubrication would hinder burnishing.

My choice of lubricant for burnishing pivots is Hoppe's no. 9 gun oil which is available wherever gun supplies are sold. And, as stated above, I use the same oil for burnishing pivot holes as I'm going to use to lubricate the clock.

Types of Burnishers

Right-Hand vs. Left-Hand: Burnishers can be purchased for use as either right-handed or left-handed (figs 8 & 9). The distinction is the shape in the profile of the burnisher. A burnisher will usually have an edge, which is relieved to allow for clearance against the shoulder, so as to provide a sharp transition between the pivot and shoulder.

Fig. 8-Right-hand burnisher with an edge which has been relieved for top use with work on the right-hand side or beneath work on the left.

Fig. 9-Left-hand burnisher with an edge which has been relieved for top use with work on the left-hand side or beneath work on the right.

A right-hand burnisher will allow the clockmaker to burnish the pivot from underneath with the piece being held and rotated from their left. A left-hand burnisher will allow burnishing from underneath while being held on the right.

If the preference is to burnish from over-the-top, a left-hand burnisher is used with the piece being held on the left and a right-hand burnisher with it held on the right. This can add confusion as to which burnisher to purchase. Since most machinists will machine with the piece being held in a lathe headstock on their left whether they are right- or left-handed, it should first be decided whether burnishing will be done from underneath or over-the-top.

I prefer burnishing from underneath, since that allows me to see the pivot as well as the trace it leaves in the oil on the burnisher. Both methods will produce a burnished pivot, however.

File/Burnisher Combo: Some burnishers come mated to a pivot file (fig 10). These can shorten the time it takes to polish and burnish a pivot since it only takes a flip of the tool to transition from polishing with the pivot file to burnishing. This eliminates the time it takes to put down one tool and pick up another.

Fig. 10-File/burnisher combination.

Steel Burnishers: Most commercially made burnishers are made of high quality steel and are capable of many years of burnishing, often outlasting the user (fig 11). These are available in either right- or left-hand versions and are easily re-surfaced when they become worn.

Fig. 11-Steel burnisher and handle.

Carbide Burnishers: Carbide is a type of steel which is harder than the steel used in most clocks. This characteristic is advantageous since a burnisher made from carbide will polish and burnish in one step. Although not commercially available, a hand held carbide burnisher can be made at a minimal cost (fig 12).

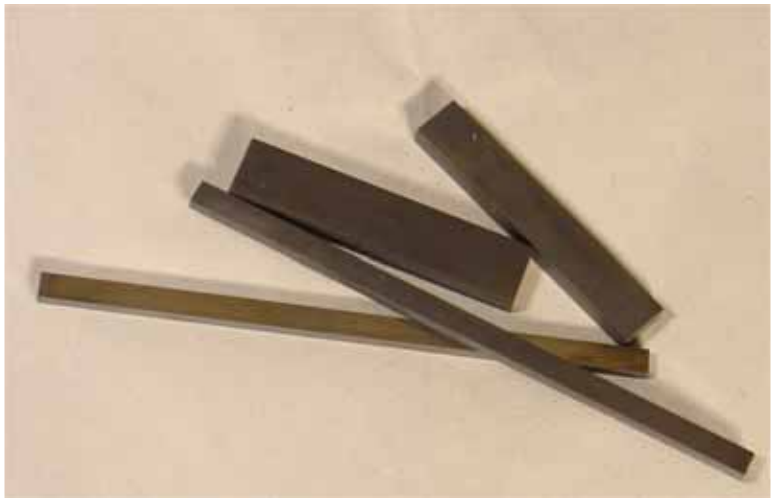


Fig. 12- An assortment of homemade carbide burnishers.

Morgan Pivot Polisher[3]: This is a lathe attachment that has a carbide wheel which burnishes as it polishes (fig 13). Although more costly than a hand-held steel or carbide burnisher, this tool will increase the speed and accuracy with which a pivot can be burnished.

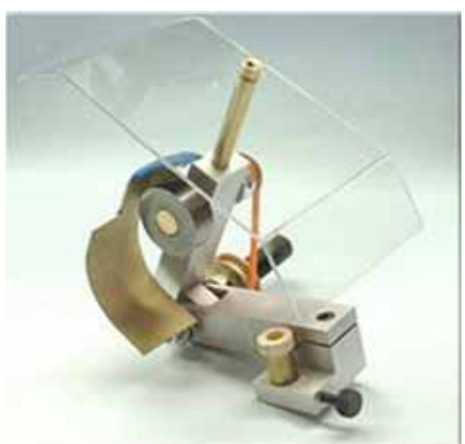


Fig. 13-Morgan Pivot Polisher[3].

Smooth Broach: This tool is specifically designed to burnish pivot holes. Full sets are available which will cover most pivot hole sizes encountered in clockmaking (fig 14). Some smooth broach sets come with handles attached but with others, it will be necessary to attach them to a handle in order to use them.

Fig. 14-Set of new smooth broaches.

Pegwood: Although not used to burnish metal, pegwood is necessary for burnishing the pivot holes in wooden works. An inexpensive source of pegwood is round toothpicks (fig 15).

Fig. 15-Pegwood and toothpicks.

The Steel Burnisher

Fig. 16-Various steel burnishers and file/burnisher combos.

Prepping the Burnisher:

In order for the burnisher to properly burnish a pivot, it must have a surface which will grab and stretch the steel of the pivot. The surface must also be flat and free of pits or other defects. If the surface of the burnisher develops any defects as a result of use, it must be re-prepped (fig 17).

Fig. 17-A burnisher will need to be re-prepped if it develops wear lines. These will show up as lines running the length of the burnisher and can be clearly seen in the photo.

Fig. 18-Steel burnisher after prepping. There are no lines running the length of the burnisher and the finish is even.

In order to assure the surface of the burnisher is flat, the prepping is done with a thick glass plate for support (fig 19). Crocus and Emery cloth sandpaper are used as abrasives to bring the surfaces of the burnisher to a proper finish; one side coarse and the other fine. Having two grades on the burnisher will make the burnishing process go much faster since the coarse side will remove any fine lines on the pivot, while also hardening it, and the fine side will bring the surface to a very high sheen as it burnishes.

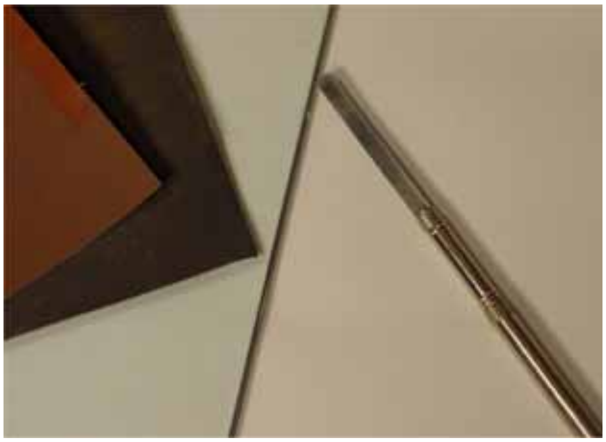


Fig. 19-Tools for prepping a steel burnisher include sandpaper and a thick glass plate.

Fig. 20-Holding the edge of the burnisher handle against the edge of the glass will ensure the lines stay the proper direction.

In order to ensure that the finish on the burnisher has lines running the proper direction, the handle of the burnisher is held against the edge of the glass plate to act as a guide (fig 20). Working the burnisher back and forth across the plate and sandpaper will bring the surface of the burnisher to an optimal finish (fig 21).

Fig. 21-Method of prepping a steel burnisher. Get comfortable, it may take a while.

With a steel burnisher, it is important to keep a close eye on the condition of the surface of the burnisher since any scoring in the finish will be transferred to the pivot being burnished. Any lines running the length of the burnisher will indicate wear spots and the need to re-prep the burnisher. These wear spots are grooves in the burnisher that will score the pivot and damage the fine finish that is so hard to achieve. They can trap metal filings that, instead of being pushed aside with the oil, will scratch the surface of the pivot as the burnisher is moved. The grooves can also cause the steel of the pivot to raise, or burr, as the pivot finish tries to form to the groove. This condition will make burnishing quite frustrating.

The Carbide Burnisher

One of the advantages of a carbide burnisher over a steel burnisher is the fact that the carbide burnisher will rarely, if ever, need to be re-prepped. This will save time as well as ease the frustration of having to stop and prep a burnisher right in the middle of burnishing. A carbide burnisher also saves time since it is possible to go from the pivot file directly to the burnisher without an intermediate polishing step.

The disadvantage of the carbide burnisher is that it must be made. The initial prepping process can take quite a bit of time, nearly eight hours, and special tools must be purchased to bring the finish on the slip to the proper consistency. The special tools may be used for other purposes so their cost can be deferred.

<u>Making the Burnisher</u>:

Since carbide is very hard, a diamond lap and diamond hone[4] will be necessary to prep the surface (fig 22).   EZ-E Lap[5] products, available at most wood working supply shops, come in different grades and have a large enough surface to make prepping possible. The fine, or extra fine, grade will give a satisfactory result but the burnisher will need a coarse side as well so a diamond hone[4] will also be necessary. The hone has a coarse grit and will give the burnisher a slightly deeper grain.

Fig. 22-Tools for making a carbide burnisher include kerosene, diamond lap[5], diamond hone[4], and a shop towel. The soon-to-be carbide burnishers are shown in the tubes[4].

The surface of the carbide slip[4], or tool bit, will have a frosted appearance and is unsuitable for use as-is (fig 23).

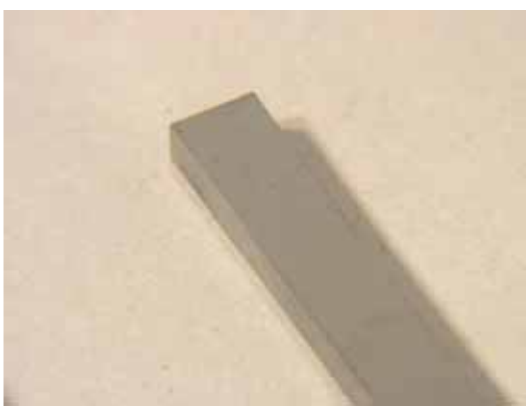


Fig. 23-Carbide tool bit before prepping showing no evidence of lines.

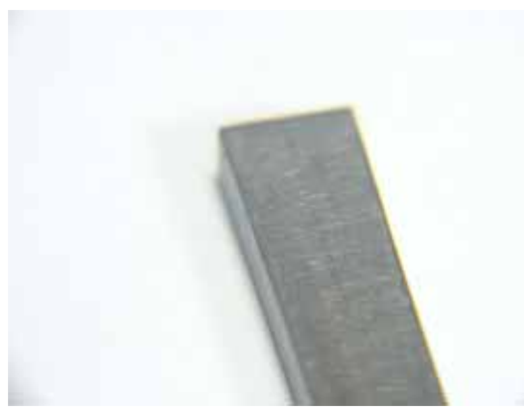


Fig. 24-Carbide tool bit, now turned burnisher, showing a proper finish. Compare this finish to that on the prepared steel burnisher in fig 18.

When making a carbide burnisher, start by working the blank over the EZ-E Lap[5], keeping the blank perfectly flat, and moving it so as to produce a cross grain (fig 25). It is best to use some lubricant, like kerosene. The grain should be perfectly straight across the width of the blank and the finished burnisher should have a flat surface. It will seem to take forever but work the carbide over the lap until the surface is even. Don't be tempted to rush the process or the finish will suffer. As the prepping process progresses, the surface will show different colors (fig 26). One shade will be the new, prepped surface being put on the blank and the other will be the gray, unfinished surface. When this process is complete, the burnisher will have two sides with fine grain surfaces. But, it is advantageous to have a coarse end on the burnisher since it makes the polishing/burnishing process go faster.

Fig. 25-Method of prepping. The back and forth motion must be carefully maintained so as to keep the lines on the burnisher running the proper direction.

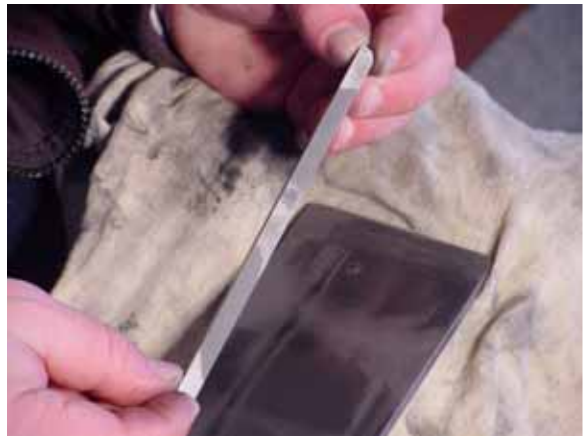


Fig. 26-After a short time of prepping, the burnisher will show where the high and low spots are. Once the whole surface of the burnisher is the same color, the prepping is done.

Once both surfaces have been done (it isn't necessary to do the sides), pick one end of the burnisher to become the coarse end. It can be the end with the most problems. Put the end in a vise, with the top edge just above the jaws. Then, use the edges of the vise as a reference to help keep the surface of the burnisher flat (fig 27). Use the Diamond Flat Hone[4] to make coarse lines straight across one half of the surface of the burnisher. Flip it over and do the other side (fig 28).

Fig. 27-Prepping the carbide burnisher with a coarse end using the diamond hone[4].

Fig. 28-Carbide burnisher showing a fine grain finish, top, and a coarse grain, bottom.

At this point, take the burnisher back to the lap and roll the edges to take off any sharpness (fig 29). A sharp edge will cut too aggressively, leaving unwanted marks on the pivot finish. Lubricate the lap with kerosene and drag the edge of the burnisher while rotating it. One or two passes is all it takes.

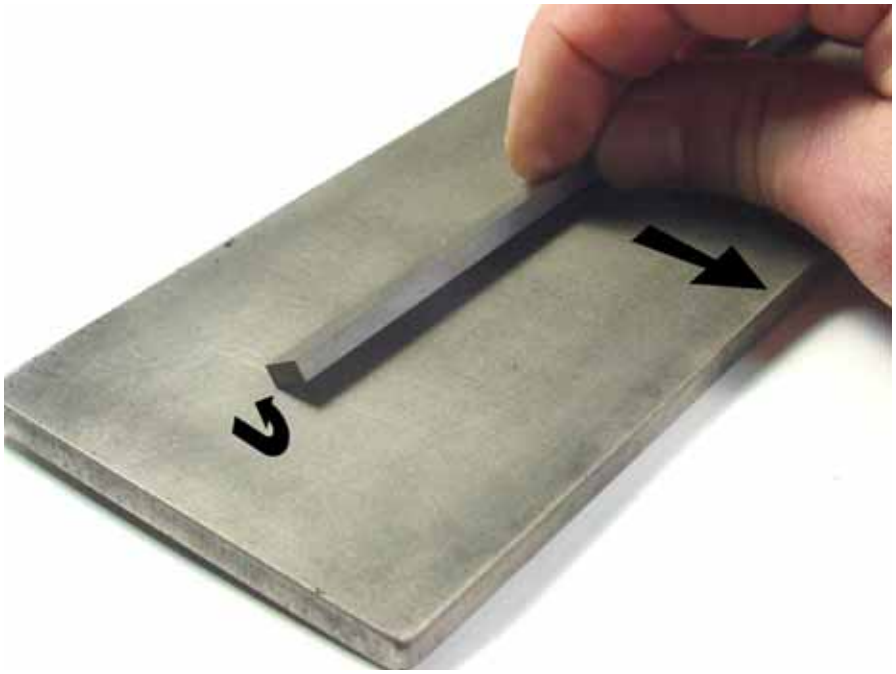


Fig. 29-Rolling the edges of the burnisher may be necessary to remove any sharpness that could cut the pivot, or shoulder, too aggressively.

The burnisher is now complete, but the coarse end may need to be knocked down if it cuts too aggressively. This can be done by moving it across the lap, as in the initial step, until it performs properly.

Using a Burnisher

(Wear safety glasses!)

A true test of skill is burnishing a pivot by hand. It takes many hours of practice and frustration just to become moderately proficient and years before the task becomes routine. This may sound discouraging but, once mastered, the craftsman will gain an enormous sense of accomplishment knowing that the quality of workmanship is beyond reproach.

Describing how this is done is nearly as difficult as doing it. It is important to start with a pivot that is straight, true, and has been properly polished. The basic hand skills necessary for burnishing can be practiced while using a pivot file to polish a pivot but they must be fine tuned for burnishing. There are two basic methods; over-the-top and from underneath (figs 30 & 31).

Fig. 30-Hand position for burnishing over-the-top. Note: The index finger is supporting the pivot and adding to the feel for keeping the burnisher flat.

Fig. 31-Burnishing from underneath gives the craftsman visibility of the pivot. Since the work is very close, eye protection is a must.

Burnishing is a combination of pressure and speed. It will often be necessary to vary the speed of the lathe as well as the pressure of the burnisher against the pivot. Burnishing starts out with a light pressure and slow speed, then works up to high pressure and high speed. In order to work out any imperfections, the steel of the pivot is massaged and caressed by slight pressure changes of the burnisher against the steel. Sometimes it is necessary to apply pressure on the left side of the burnisher, to work an area close to the shoulder, and other times the pressure is applied on the right, to work the end of the pivot. It is more a pressure variation rather than any rotation of the burnisher. It is advantageous to watch the oil trace on the burnisher in order to determine where the pressure is actually located. The oil will be pushed away from the burnisher in the area of pressure and this will provide visual feedback to the hand pressure. There must be a balance to the amount of pressure being applied since too much pressure against the pivot will bend or break the piece and too little pressure won't burnish.

In addition to burnishing the surface of the pivot, special attention should be paid to burnishing the shoulder as well. This is done by putting pressure against the shoulder, with the side of the burnisher, during the burnishing process. It will quickly become second nature to apply that lateral pressure while burnishing, making it almost automatic to burnish the shoulder. Like the pivot, the shoulder is a bearing surface and the movement will benefit from its being polished and burnished.

With more experience in burnishing comes a better feel with the burnisher on the steel. It will be possible to feel the steel become hard and polished. It will also be possible to feel when things go wrong, like when a particulate is trapped between the burnisher and the pivot, causing a severe scratch in the finish. That is why it is important to keep the burnisher free of particulates by frequently wiping it clean and lubricating with fresh, clean oil.

And, to make matters more difficult, the clockmaker or watchmaker must do all these things while working very close to rapidly spinning wheel teeth and protruding pins (fig 32). Cuts are common when burnishing but can be minimized with the proper techniques. It is important to know where the danger is, and this can be done with sensory feedback. Allowing the wheel or pin to just graze a finger during the polishing and burnishing process will cement its location in the mind and fewer accidents will occur. A scrape or cut is more likely to occur when motions are quick and careless and less likely when easing into the work and knowing where the dangers lie.

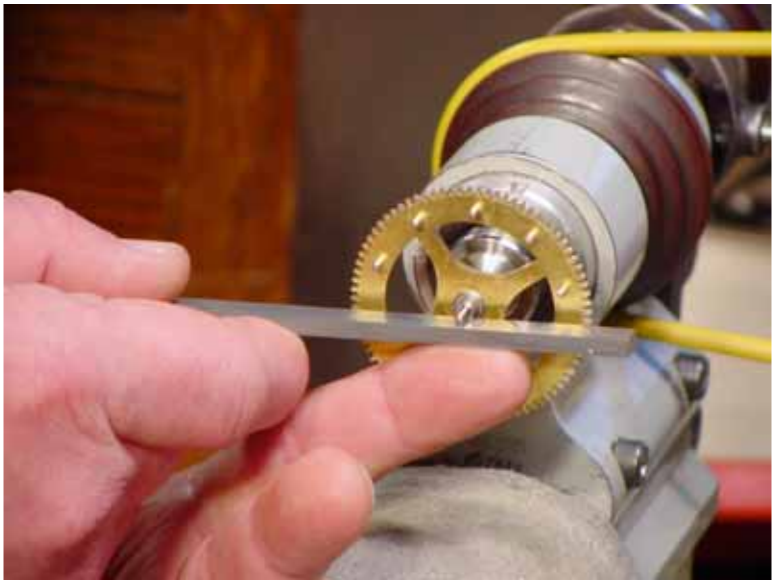


Fig. 32-Burnishing a pivot can sometimes be dangerous. It is best to know where the danger is and maintain a sure touch with the burnisher.

Another important technique to master is the ability to remove the burnisher from the work without causing damage. It should be pulled straight down and away from the pivot without dragging. If the burnisher is moved carelessly across the pivot surface during the take-away, it is likely to damage the freshly burnished surface…then you start over (fig 33). This is actually more difficult to do than it sounds since all of the muscles in the hands and arms, which up to this point have been used to keep the burnisher against the steel, are now asked to instantly reverse direction with very little time to relax.

Fig. 33-A poor take-away of the burnisher will cause damage that is best to avoid. Shown here is the result of accidentally dragging the burnisher across the pivot as the burnisher is being taken away.

Occasionally, a pivot will show damage that isn't necessary to be removed (figs 34 & 35). If the imperfection on the pivot surface is not part of the bearing surface, it can be left as- is. In fact, it is best to leave it since its removal would require reducing the bearing surface unnecessarily.

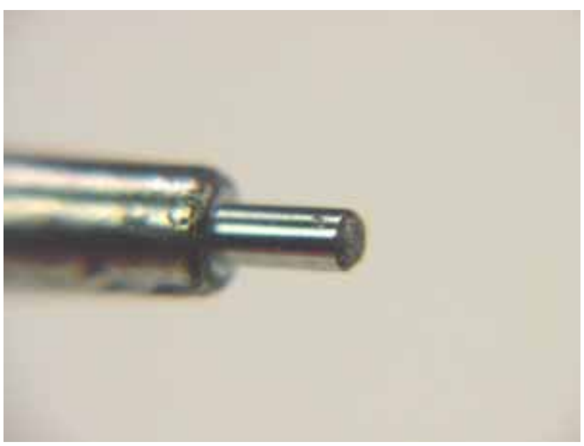


Fig. 34-Some imperfections on a pivot aren't necessary to be removed. The defect on the end of this pivot, for example, is a good candidate for one that can be left as is.

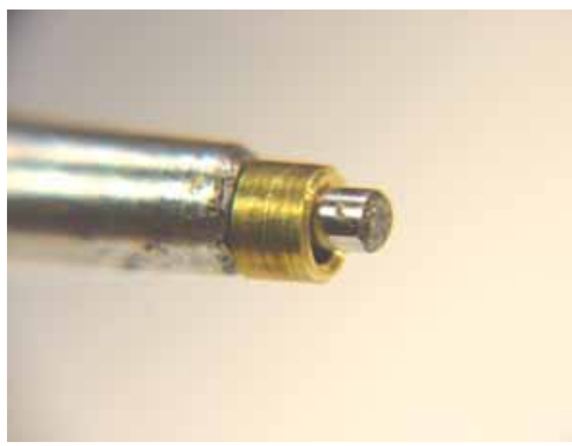


Fig. 35-If the defect in the pivot finish isn't on the bearing surface, there is no reason to reduce the diameter of the pivot in order to remove the defect. In this case, the defect is well beyond the pivot hole and can be left as is.

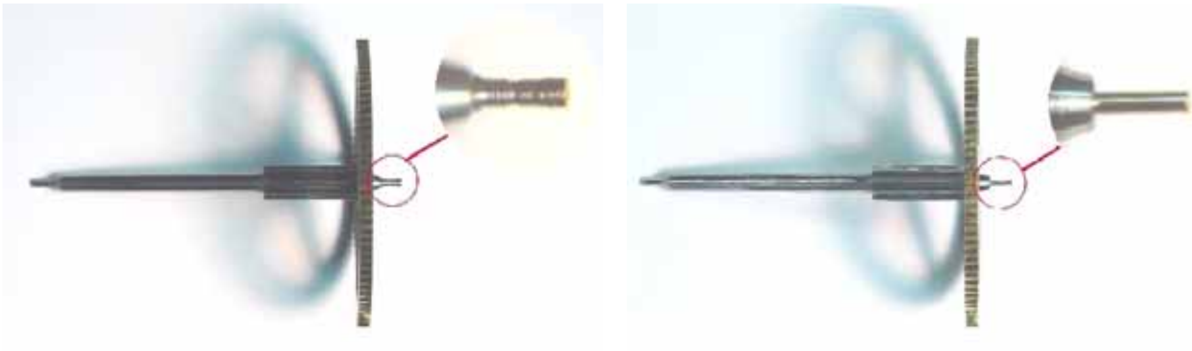


Fig. 36-An example of an "I" shaped pivot before polishing/burnishing (left) and after (right).

Morgan Pivot Polisher[3]

This is a lathe attachment that uses a carbide wheel to polish and burnish pivots (fig 37). The wheel comes already prepped with a finish that is designed to accomplish this task quickly and efficiently. The wheel is rotated independently of the pivot to provide the most effective pivot finish possible. This is a wonderful tool when properly used and is easily adapted to most lathe setups.

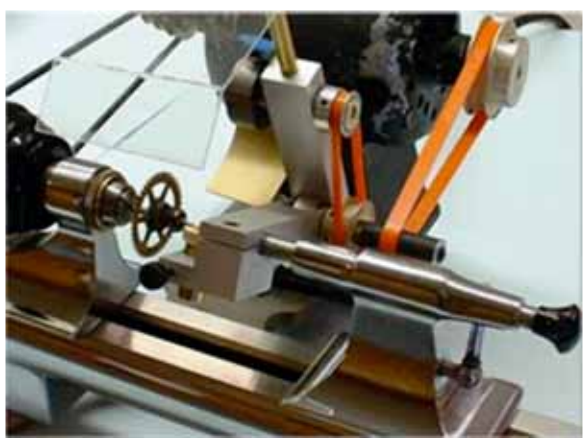
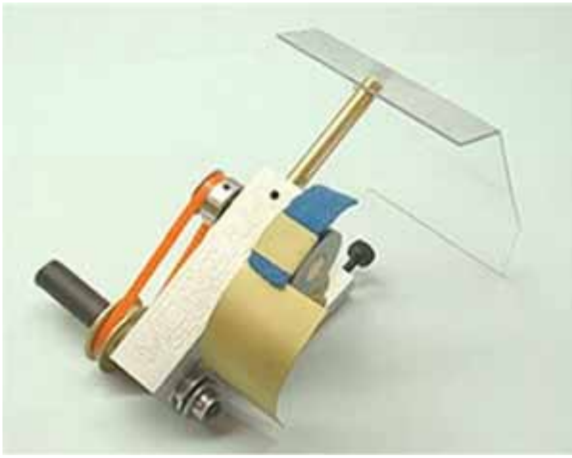


Fig. 37-Morgan Pivot Polisher[3] shown in use on a WW lathe. With the proper hardware, this tool can also be used on a Sherline lathe.

The Morgan Pivot Polisher[3] is held in the tail stock of a lathe, or a bracket designed for that purpose, and is driven by the lathe motor or a separate, dedicated motor. It has a pivot rest which supports the pivot during the polishing/burnishing process and a carbide wheel which is extra wide to accommodate long pivots.



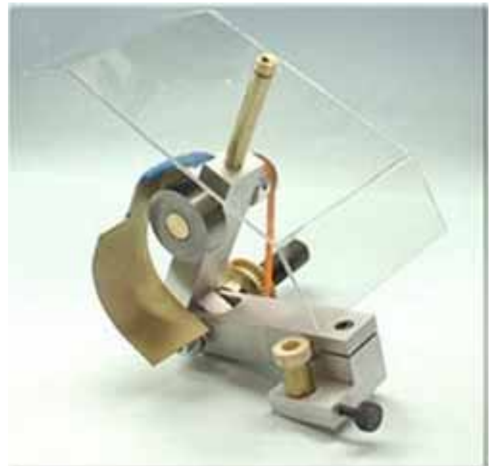


Fig. 38-Two views of the Morgan Pivot Polisher[3]

Lubrication: The cutting surface of the carbide wheel should be lubricated while polishing/burnishing a pivot in order to obtain the best pivot finish. The polisher comes with a splatter shield to protect the user from being sprayed with lubricant. Special lubrication for this device is available from the Morgan Clock Co[3].

Rotational Direction: It is important that the carbide wheel, and the pivot being polished, rotate in opposite directions. This will guarantee that the wheel will actually cut rather than just roll over the pivot. The polisher is designed with this in mind and, when driven with a double-ended lathe motor, the wheel will rotate the proper direction. When using an independent motor to drive the polisher, be sure both motors are rotating the same direction to ensure the carbide wheel is rotating opposite the pivot. Occasionally, the pivot surface will become so hard from burnishing that the carbide wheel stops cutting. If this occurs, it is advantageous to reverse the rotation of both wheel and pivot and burnish in the other direction. This will frequently allow the carbide wheel to cut through the hard surface and continue the polishing process.

Burning a Pivot: Too much pressure or too high a speed will cause the pivot surface to develop a discoloration in the form of a brown ring (fig 39). This is an area of the pivot which has been over heated and "burned" and is now softer than the surrounding metal due to annealing. Also, the pivot will burn if the pivot surface becomes harder than can be easily cut by the carbide wheel. To remove the burned area, changing the rotational direction of the wheel and pivot may be sufficient to remove the hard layer. If that fails, it may be necessary to use a stone on the pivot to remove the hard surface before resuming with the carbide wheel.

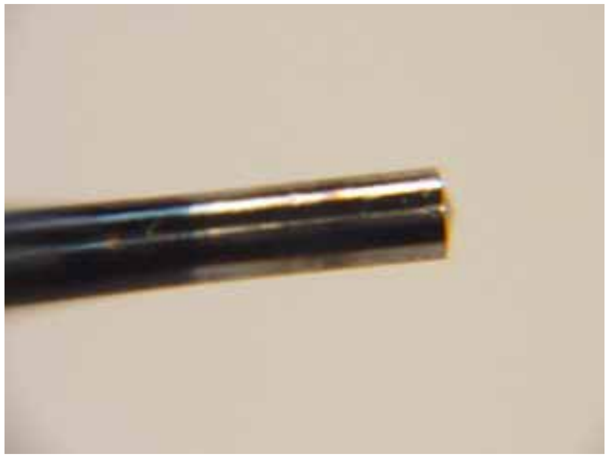


Fig. 39-Example of a burnt pivot (shown on pinion wire). Note the discolored, brown rings in the middle of the burnished area.

Tapering a Pivot: If the pivot isn't kept exactly on center, i.e. if it is a bit high or a bit low, the pivot will be ground with a taper. This is adjusted by raising or lowering the pivot rest until the pivot is exactly flat and true. It is often an advantage to raise and lower the pivot rest during polishing in order to work a stubborn area. This will speed up the polishing/burnishing process.

Cutting a New Shoulder: One thing to watch for when using this tool is that it will cut a new shoulder unless the carbide wheel is pressed tightly against the existing shoulder (fig 40). If there is a slight gap between the shoulder and the carbide wheel, a new shoulder will result when the pivot diameter is reduced during polishing. This is a problem since a new shoulder will reduce end-shake and could cause a bind. It is often easiest to move the shoulder snug against the wheel rather than the wheel against the shoulder.

Fig. 40-Grinding a new shoulder, like this one, should be avoided when using the pivot polisher.

Watch the Oil Trace: It is often difficult to determine when the pivot is properly polished and burnished since the carbide wheel hides the pivot surface. Repeated close examination of the pivot during polishing will greatly slow the process. One way to avoid this is to closely watch the oil trace on the surface of the carbide wheel. As the pivot is being polished, it will leave a trace in the oil which can be “read” to determine the state of the pivot. Wear spots on the pivot will show up as lines in the oil trace while the absence of wear will show up as a clear trace all the way to the end of the pivot. The trace will also show which area of the pivot is being polished. For example, a clear trace at the edge of the wheel means the pivot is only being cut at the shoulder and the pivot rest may need to be adjusted to avoid a tapered pivot.

Smooth Broach

A smooth broach is a round, tapered, steel tool which is used to burnish brass pivot holes or bushings (fig 41). Burnishing a pivot hole is just as important as burnishing a pivot and the most effective way of accomplishing this task is with a smooth broach. But of course, these must be properly prepped, just like a burnisher.

Fig. 41-A smooth broach with a pin vise used as a handle

Prepping: New smooth broaches, right out of the package, will not have a finish suitable for burnishing (fig 43). They must be prepped with sandpaper, steel wool, and/or Scotchbright before they will function properly (fig 42). The easiest way to do this is by chucking up on the burnisher in a lathe and working the abrasive over the surface of the burnisher until the desired result is achieved. 600 grit sandpaper (for metal), followed up with Scotchbright and 0000 steel wool, will generally produce a fine result. Take care when prepping the broaches since they have very sharp points and can easily become lodged in a finger or palm.

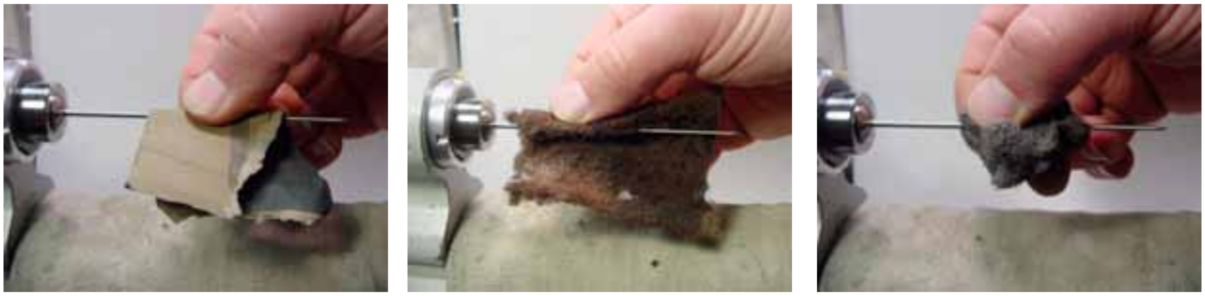


Fig. 42-Prepping a smooth broach may need to be done in several stages to obtain the optimal finish. Fine grit sandpaper, followed by Scotchbright and steel wool, produces a nice result.

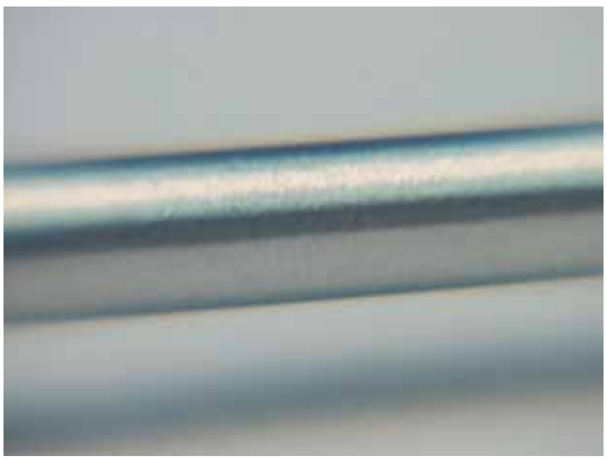


Fig. 43-The finish on a new smooth broach is unsuitable for burnishing and must first be prepped.

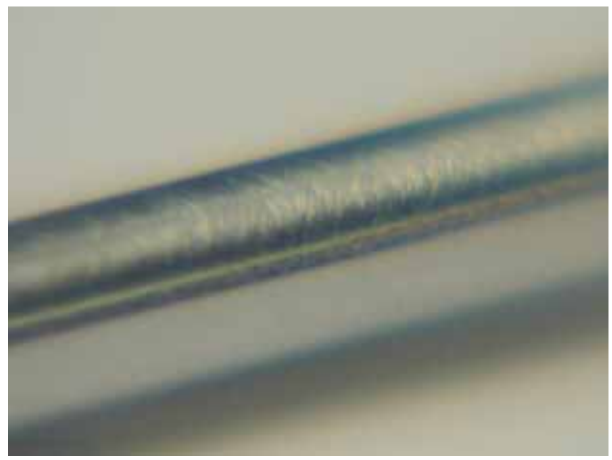


Fig. 44-After prepping, the surface of a smooth broach will show fine scratches which will aid in hardening the surface of a pivot hole.

Fig 45-A new smooth broach, top, as compared to a freshly prepped one, bottom. Note: Even though the prepped smooth broach has a scratched finish, it has a brighter sheen than one which is not prepped. This shows the prepping process removes any contaminants that may be on a new, unprepped broach.

Burnishing With a Smooth Broach: This is done once all of the pivots have been burnished, all of the bushings have been installed, and all of the bushings have been sized. As a note: burnishing with a smooth broach will make the pivot hole slightly larger and this should be taken into account when sizing the bushings.

First, choose the proper size broach for the pivot hole. It will be the one that gets tight in the hole about 1/3rd of the distance from the end, which allows some flex in the broach while burnishing. There is a great amount of leeway here but it is important to avoid trying to use a broach that gets tight at an extreme. Too close to the tip will cause damage to the pivot hole, while too close to the end makes it difficult to burnish properly.

The broach should be lubricated with the same oil that will be used in the pivot hole. This will avoid any possibility of the oils becoming contaminated and the pivot failing prematurely. The lubrication can be applied to a clean finger and then spread over the area of the broach that will be used. When the oil on the broach becomes dirty, clean the broach on a towel and apply new oil. This will be more noticeable on pivot holes that haven't been bushed since the brass in the old hole will have embedded particulates which will come out with the burnishing process.

The smooth broach shouldn't be wedged hard into the hole but should instead be slightly wallowed around (fig 46). This technique requires a light touch and involves twisting the broach while at the same time articulating it in a circle (conically). The pressure applied with the broach is equal parts wedging and wallowing but not so much pressure that there is risk of breaking the broach. If the broach is wedged tight in the hole, or the wallowing is too extreme, it will cause the pivot hole to become over-sized. Wallowing takes advantage of the flex in the broach to offer a better "feel" while burnishing. This "feel" will enable the clockmaker, or watchmaker, to burnish the pivot hole while minimizing the amount the hole is enlarged. This makes it much easier to predict how much the hole will change, and easier to account for it when sizing the pivot hole, since the results are consistent.

Work the hole equally from both sides of the plate to ensure it is fully burnished and true.

Fig 46-Wallowing a smooth broach to burnish a pivot hole is done by a combination of twisting the handle and articulating the broach in the pivot hole. This will afford a greater degree of “feel” while burnishing and minimize the amount to which the hole is made larger during the burnishing process.

Once the pivot hole has been burnished, rinse or wipe off any excess oil and check for burrs that may have been raised in the burnishing process. Although more likely to occur when sizing a bushing, a burr can form on the edges of the pivot hole due to the pressures involved when burnishing. These burrs should be removed or they will cause end-shake problems.

The final step in burnishing a pivot hole is cleaning out the hole with pegwood. This will guarantee a clean, dry, burnished hole with no contaminants. Toothpicks work well for this process since they are disposable. The pegwood will collect dirt rather quickly and must be frequently changed. Insert and twist the pegwood into each pivot hole and repeat until the pegwood comes out clean, replacing the pegwood (or toothpick) with fresh when dirty. This will leave small wood particulates behind which should be blown off with a hand bulb. Don’t blow them off with a burst of air from your lungs, as this will introduce unwanted moisture.

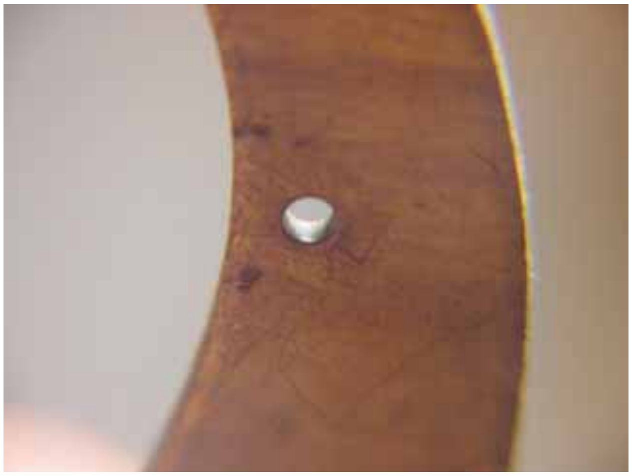


Fig 47-A clean pivot hole before being burnished with a smooth broach.

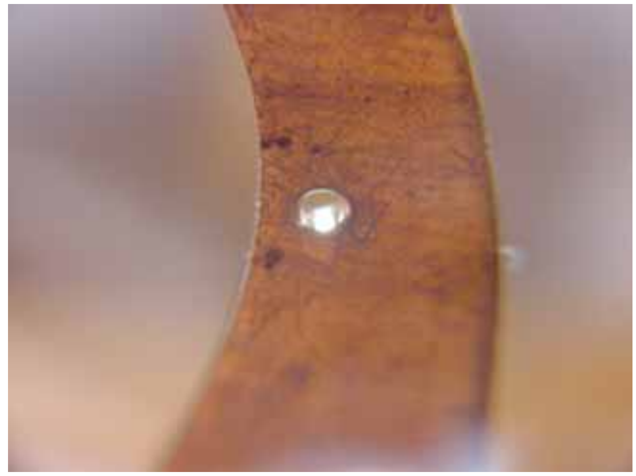


Fig. 48-After burnishing, the pivot hole is bright and shiny. A close examination of the plate, while being backlit, will quickly show if any pivot holes have been missed!

Pegwood

Commercially available pegwood is either orange wood or dogwood but good quality round toothpicks will work. Pegwood is generally used to remove any residual chemicals or oils from brass pivot holes but can also be used as a burnisher when the pivot hole is wood, as in a wooden movement.

To use pegwood as a burnisher, hold it in a lathe, or Dremel tool, and spin at a fairly high speed. When turned at high speed, and then inserted into a pivot hole, the pegwood will squeak as it burnishes the pivot hole and actually become burnished itself. Burnish from both sides of the plate, and replace or reshape the pegwood when well-used.

Using toothpicks as pegwood is faster, easier, and more cost effective since there is no need to carve them to shape and toothpicks are very inexpensive. When burnishing, the toothpick will compress and even become dense enough to burnish oak bushings. And when the toothpick gets worn beyond use, throw it away and use another.

1. Simichrome and buffsticks can be found at many clock supply houses.

2. Craytex is a rubberized abrasive available in sticks, ¼”x ¼”x6”, from KBC Tools.

   1-800-521-1740 (USA)
   1-888-KBC-TOOL (Canada)
   www.kbctools.com.

   -Part # 1-614-6262XF (extra fine grit)

3. Morgan Pivot Polisher photos used with permission. Dan Morgan, Morgan Clock Co.

   Morgan Clock Co.
   815 Century Dr.
   Dubuque, IA 52002
   Phone (563)583-2220 Fax (563)583-6849
   http://www.morganpivotpolisher.com/

4. The carbide blanks and diamond hone are available from J&L Industrial Supply.

   1-800-521-9520 (US)
   http://jlindustrial.com/.

   Part numbers:
   -1/8 x 1/4 x 6 Carbide Blank no. STB48E
   -Diamond Flat Hone no. ESE-11000M

5. The EZ-Lap is available from wood workers supply houses like Woodcrafters.
   or
   EZ-E Lap Diamond Stone
   Box 20469
   Carson City, NV 89721

6. And a special “Thank you!” to my son, Seth, for being available to take pictures.