Everything you always wanted to know about clock mainsprings.

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The most important thing to remember, when dealing with clock mainsprings, is that they are VERY dangerous. That is because they are full of potential energy just waiting to be released. Mainsprings have the power to lacerate, cause blindness, and destroy clock parts that you did not quote when you estimated your repair.

So PLEASE be CAREFUL and always wear eye protection (goggles) and glove your hands (leather is preferred).

Properly dealing with clock mainsprings involves identification, eliminating the power, removal, inspection, cleaning, lubrication, replacement or repair, and installing.

1) Identification

There are basically two (2) types of clock mainsprings. They are hole end, and loop end. The hole end is used inside a barrel and has a "D" or oval shaped hole at one end of the mainspring. This allows the mainspring to be attached to a fixed point such as a barrel hook. The loop end has either an oval or round closed end to allow a post or other fixed movement stem to be used as the “anchor" of the mainspring. On smaller loop end mainsprings, the loop end can be open.

2) Letting down or removing the power

ALWAYS, ALWAYS, ALWAYS, the first thing you MUST do after identifying which type of mainspring that you have, is to let the power down. This means to take the power off the mainspring so it can be safely handled and removed from the movement and/or barrel.

99.9% of spring driven movements have click(s) and click spring(s). These items along with the ratchet wheel allow you to wind in one (1) direction while they keep the mainspring from unwinding. This is due to the fact that the click makes contact with the ratchet wheel and the ratchet wheel is affixed to the main wheel arbor (axle). It is these clicks and click springs that will allow you to "unwind" or take the power off the mainspring. There are some exceptions in alarm, travel, and one particular 400-day clock but I’m not going to cover that in this article.

The hole end mainspring is associated with a barrel. The click, click spring, and ratchet wheel are usually found on top of the front plate or winding side of the movement but can be found elsewhere such as underneath the barrel. The barrel will act as a "prevent" or limiter and not allow the mainspring to unwind into the other gears.

On the loop end mainspring, the click, click spring, and the ratchet wheel are usually on the same side of the wheel that you wind. They are usually attached directly to the main wheel. The trouble with the loop end is that there is usually nothing preventing the mainspring from unwinding into the other gears, as you let the power down. To solve this problem you must use something to act as a barrel or retainer. You can use mainspring clamps, which usually come with a new

mainspring or you can use any strong wire and tie the entire circumference of the mainspring before you let it down. I personally use new electrical cord or speaker wire.

To let the power down, you will need a set of let down keys. These are sometimes called bench keys. Let down keys usually have their own size keys for proper fit on the mainspring-winding arbor. You can also find let down handles and keys that will allow you to use the original key used in "normal" winding to let down the mainspring.

First find the right size let down key and place it on the winding arbor. Then release the spring part of the click spring (usually on loop end mainsprings) but sometimes you will have to hold the click away from the ratchet manually (usually on hole end mainsprings). When you release the click spring, the click will stay in place because of the potential energy stored in the mainspring. But when you manually release the click from the ratchet wheel be prepared to hold the bench key firmly because that is the only thing from letting the mainspring unwind at a very fast and uncontrollable speed. The same goes for when you start to wind the mainspring and gently push the click out of the way (on loop end mainsprings mostly). This winding process is actually the start of the let down procedure. Wind a small amount, in the tightening direction, so it is just enough to allow you to "clear" the click from the ratchet wheel.

With nothing to prevent the mainspring from unwinding, it is you and the let down key that have all the power. So make sure the movement is secure because it can start moving and it can "get away" from you and cause all kinds of damage. Now start to let up on the holding pressure on the hand holding the let down key. The mainspring will start to unwind. Unwind the mainspring as slowly as you can comfortably without letting the mainspring down too fast. Here is where experience can teach you much more than I possibly can in this article.

3) Removal

There are two (2) ways to remove the mainspring that is in a barrel or hole end spring. The preferred way is to use a mainspring winder. Thereby winding the mainspring until the barrel easily slips off the mainspring and is "captured" by the winder, usually using a "sleeve" that comes with the winder, and then slowly "unwinding" the mainspring into the sleeve. You will first have to remove the barrel cover. This will be covered in the next paragraph. Some winders allow you to use the original arbor in order to let down the mainspring.

The method I use is to remove the barrel cover is by hitting the opposite end of the winding arbor with a brass, nylon, or fiber head hammer. This action will loosen the barrel cover. If you need to remove the winding arbor, you can do this by turning the arbor in the opposite direction that would wind the mainspring and pull to remove.

The other removal method is to remove the barrel cover and then grasp the two (2) inner coils (the ones closest to the center) with a pair of smooth faced pliers and gently pull the coils out until they are "free" of the barrel. I then slowly and steadily pull the "exposed" coils, by hand, until the mainspring starts to come out. When several coils are "exposed", I then grasp the coils with my gloved hand and "guide" the rest of the mainspring out of the barrel. What I mean by guiding is NOT pulling on the spring but a sort of twist and tug which will loosen the coils and the mainspring will almost come out on its own. So please be CAREFUL. This is something that you must "feel" as you go and it takes some practice.

I should stress here that this could be dangerous because if you do not have adequate control of the unwinding, the mainspring could "jump" out at you causing damage to yourself, the barrel and the mainspring. Also, if you pull too hard you will elongate the mainspring then it will not lie flat. A mainspring that does not lie flat will rub the top and/or bottom of the barrel and lose power by not delivering a smooth power "flow". This rubbing on the barrel cover may work the cover off over time. This is called a "conned" mainspring.

Removing a mainspring that is a loop end is fairly straightforward. The mainspring should be fully wound and then clamped. Clamps can be purchased or you can use either steel wire or “new” lamp cord or speaker wire. Make sure that whatever you use, as the mainspring clamp, is strong enough to hold the mainspring in place while you unwind. This way you can remove the entire mainspring (clamp and all) along with the rest of the movement's parts.

Once the mainspring is out of the movement you have the added problem of removing the mainspring clamp. Simply treat it like you would any other barreled mainspring and use the instructions above which is either using a mainspring winder or by hand.

4) Inspection

The inspection of the mainspring is done at the same time as the cleaning. I take a plant hanger screw (not the hook) and insert it into a sturdy and permanently attached wood bench or other piece of old "not-too-important" furniture. The kind of hanger I use is designed to go into a stud so it has a wood screw end and machine thread end. Purchase at least two (2) hangers and place one vertical and one horizontal. Using the vertical for hole end mainsprings and the horizontal one for loop end. You will also need a butterfly nut, which is the same thread as the machine thread on the hanger. In this way you will be able to "capture" the end of the mainspring as you clean and avoid accidents. You may use a vise for securing a mainspring. By this I mean, placing a screwdriver through the hole or loop end and then place the screwdriver in a vise. This will give you a fixed point for your inspection and cleaning.

By the way it is still VERY important to wear protective eye wear (goggles) and gloves because of potential breakage while working on the mainspring. You are now ready to attach the end of the mainspring to the hanger, capture it securely, and then insert a sturdy and long screwdriver in the inner coil of the mainspring to act as your puller. By simply backing away from the captured or fixed point you will be able to slowly lengthen the mainspring allowing you to inspect, clean, and lubricate. To complete the "pass", walk back to the hanger.

5) Cleaning

To clean properly you will need several things. I make six passes on the mainspring. On the first pass (the actual lengthening of the mainspring) I use a Kerosene dampened terry cloth and scrub both sides. This removes most of the dirt and old lubricant. At the same time you are cleaning the mainspring, be on the lookout for small cracks and deep rust because this is also your inspection pass. The second pass I use 3/0 (000) synthetic steel wool (dry) and please be sure to scrub the sides of the mainspring as well as the main body, top and bottom. This removes rust, some pitting, and the remainder of the dirt and old lubricant. The third pass is with a paper towel or soft clean cloth to remove any residual dirt. The fourth pass is, again with the kerosene-dampened cloth, to remove any residual particles left by the steel wool. The fifth pass is with a paper towel or clean soft cloth to remove whatever dirt and kerosene is remaining.

6) Lubrication

The sixth and final pass is for lubricating. There are many substances you can use and if you have a favorite then by all means use it.

I use a different terry cloth, which is "damp" with Slick 50 Synchron, a Synthetic Engine Formula, because it is superior for mainsprings. It has micro-granulated PTFE (Teflon) particles, which, under pressure, bond to the spring and drastically reduce the turn-to-turn friction that we feel in a mainspring when it is nearing fully wound. The base oil for the Slick 50 must be synthetic oil. Be careful when you purchase the Slick 50 because most types use non-synthetic motor oil.

In order to accomplish the bonding to the metal, wind the spring three times fully (letting is down each time of course) because that will "transfer" the PTFE onto the spring, thereby impregnating it with the Teflon.

Just make sure that whatever lubricant you choose, you don't use a lot. A light coating on the mainspring is all that is needed. If you like to use grease then please make absolutely sure that you use it sparingly. Grease spreads easily making the next repair job all the more messy and you might be that next one to work on it.

7) Replacement

If the mainspring is "set", badly conned, cracked, rusted, or in pieces, it MUST be replaced. Most clock supply houses carry mainsprings. You need to know how to order the correct size. First let me explain what a "set" or fatigued means.

The explanation below is for any mainspring that is in a barrel and most loop end mainsprings cannot be "set" because they are not contained inside a barrel and are free to expand with the only limitations being the clock case and the clock movement. If the mainspring has been sitting for a long time fully wound, it too can become set.

After removing the mainspring from the barrel, (with a winder or by hand) place the mainspring on the bench. The diameter of the uncoiled or relaxed mainspring should be more than 2 1/2 times the diameter of the barrel. If the uncoiled diameter is less than 2 1/2 times then you should replace the mainspring. For loop end, the relaxed mainspring should be more than 2 times the diameter of the mainwheel.

Please do not confused "set" with "over wound". There is absolutely NO such thing as an over wound mainspring. This expression probably started because the first thing someone does when their clock stops is wind the clock. Now since the problem is usually wear and an accumulation of dirt, all the winding in the world will not make the clock run. Therefore the clock is fully wound and not running. So someone probably said, "Well its fully wound so I guess its over wound".

To order the right size mainspring there are three (3) critical measurements in determining the correct mainspring size. These are width, strength and the length and for a hole end mainspring the inside diameter of the barrel.

For a hole end mainspring, you only need the inside barrel diameter and the mainspring's width to order the proper size. My method for determining the proper size for the hole end mainspring is really quite simple.

Looking at any mainspring chart from your parts supplier's catalog, you will see that the sizes are listed by mainspring width. Within each width size there is usually only one (1) size mainspring for each inside barrel diameter listed. Therefore you have the proper size mainspring with just the two (2) measurements of inside barrel diameter and the actual mainspring width. You can use the inside depth of the barrel leaving room for the barrel cover for the width. There is a slight indentation around the inside of the barrel for the barrel cover. Please take that into account when determining barrel depth and you will have the proper mainspring width.

Still looking at the mainspring chart, you will see that the exceptions are the widths of 4.0mm, 8.0mm, 9.5mm, 11mm, 13.0mm, and 14.3mm, which have one (1) individual barrel diameter, that have a choice of only two (2) different mainsprings. The width of 19.0mm is a little tricky because it has four (4) individual barrel diameters with a choice of two (2) different mainsprings. But for each inside barrel diameter and mainspring width you NEVER have more that two (2) choices on which mainspring is the proper one. This is where experience and common sense come into play.

With most English and German clocks the usual rule of thumb is that if the ID (inside diameter) of the barrel is 35mm then the mainspring thickness is 0.35mm. This generalization works about 90% of the time for these clocks. With these movements the inside diameter of the barrel usually gives you the mainspring thickness.

For loop end, or if you don't trust what I just stated about hole end mainsprings, let's measure. These measurements can be in inches or millimeters (I prefer inches). You should take these measurements with a micrometer or caliper and a ruler.

The width is the actual width of the mainspring or of any piece you still find lying around if the spring exploded in the barrel, which they sometimes do. If for some reason you do not have the old mainspring, then measure the inside depth of the barrel. Measure it from the bottom to the barrel cover's ledge (a small depression inside the barrel just below the top). The strength is the thickness of the mainspring and the length is the complete length of the mainspring. You'll have lots of fun trying to measure the length by laying pieces back to back from an exploded mainspring.

For most American replacement spring sizes, please see ftp://ftp.webcom.com/pub/z4murray/repair/mainspr.doc or any current clock material supply house catalog.

A comment on American mainsprings, it is now general accepted that most American manufacturers of the 1800's used mainsprings that were simply too powerful for the movement. The generally accepted reason is that with an over powered mainspring, the clock would run past the point of "normal" wear and once sold, most likely, the company would never have to honor any warranty. Also the "modern" mainspring is generally of better quality than what was used in the 1800's.

That being said, then what do we do when replacing the mainspring for the American clock from about 1830 to 1910? Most companies of that time used a mainspring that was ¾" in width. Rather than replace what was originally there it is good practice to replace with a slightly longer but weaker mainspring or one of the same width and length but weaker.

The current S. LaRose catalog # 295 has listed a ¾" X .0165" X 96" mainspring to replace the ¾" X .018" X 96" mainspring. If that is not available then you could select one that measures ¾" X .017" X 120". If your original mainspring measured ¾" X .016" X 78", then you could select ¾" X .014" X 108". Those are generally the two cases where replacing with a weaker yet longer is acceptable. I know it's hard to pass up on the mainspring specials that are seemingly always running on these popular mainsprings but both the clock and the owner will be much better off with a clock that will give fewer problems in the long run.

Also, new mainsprings, as supplied, are coated with a rust inhibitor rather than a suitable lubricant, and they need to be cleaned and lubricated, the same as used, before being put into barrel or movement.

8) Installation

The first thing to check is making sure that the inner coil of the mainspring fists snugly around the mainspring arbor. If this point of contact is too loose then the winding arbor hook may not "catch" the inner coil hole. To tighten this fit, take smooth jawed pliers and squeeze the inner coil of the mainspring. Do this by working the pliers around the last "coil" of the inner coil and keep the inner coil round so that the arbor hook can catch the inner coil hole. The mainspring arbor should require some force in order to place it inside the inner coil. This should assure that the arbor hook will easily enter the opening in the inner coil and have a good firm "fit".

To install any hole end mainspring you will definitely need a main spring winder. I'm not going to try to tell you how to use one here except to say it is fairly straightforward. I do have an article on-line that covers the Ollie Baker mainspring winder which is found at: ftp://ftp.webcom.com/pub/z4murray/repair/olliebaker.doc

On some small and very light mainsprings, such as the type that is in an Atmos clock, you can rewind by hand. But in general hand rewinding will make your mainspring not lie flat (conning, remember that problem) so just don't.

There is a small gadget for winding loop end mainsprings, which does come in handy from time to time. But in general, I like to use the movement to help wind my loop end mainspring. Simply mount the mainspring on the main wheel and insert it along with the 2nd wheel of the same train. The 2nd wheel is also referred to as the 1st wheel because it is the 1st wheel after the main wheel. I'll refer to it as the 2nd wheel. Assemble the two (2) wheels inside the two (2) clock plates and secure with whatever was securing them before you took the movement apart (either pins or nuts). Once you are comfortable with this procedure you can wind both mainsprings by inserting both main and first wheels.

Now run a small piece of speaker wire through both sides of the 2nd wheel and through both plates and secure (tie several knots). You are now free to wind the mainspring normally until it is fairly tight (I like to go right up to the point where the mainspring will probably go only one (1) more tooth on the ratchet wheel). Capture the mainspring as mentioned before and then remove the power from the mainspring as I already explained, and you're done.

8a) Proper tension where a "stop-wind" or Geneva stop exists

On some movements there are two additional wheels with one attached to the winding stem and the other attached to the plate. These two wheels stop the winding/unwinding process before the spring is actually fully wound and before the mainspring has reached the end of its potential tension. This is called a stop wind. You must determine the proper tension of the mainspring when the movement contains a stop wind.

The preferred way to determine where to place the stop is to let down the mainspring fully. Make sure there is no power being delivered to the train by removing the verge and observe that the wheels do not turn. Then wind the mainspring until the train starts to move. This will give you the zero point of the mainspring. The zero point can lightly drive the train but does not have sufficient power to drive the pendulum.

Once you have found the zero point, secure the train with either the verge of by blocking one of the upper wheels in the train and wind the mainspring fully. As you wind, count the number of turns this takes and remember most likely you will be counting half turns because of the limitations of your wrist.

Now that you have determined the total number of turns of the mainspring, the next step is to determine the number of turns the stop works will allow. You can do this by observation or by counting the “slots” in the stop itself.

What we are tying to accomplish is using only the center of the mainspring. We can determine this by taking the number of mainspring turns and subtract the number of turns the stop will allow. Then take that number and divide it by 2 because the mainspring should have the same amount of turns both above and below the useable portion that the stop wind allows.

As an example, say the total number of mainspring turns is 20 and the number of turns allowed by the stop works is 10. So, 20 – 10 = 10, and divided by 2 = 5. This means that the “unused” portion of the mainspring at both above and below the stop will be 5 turns each.

Continuing with the above example, you can apply this information in either of two ways.

a) Wind the mainspring fully and let it down by 5 complete turns and place the stop portion of the stop works at that point.

b) Again find the zero point of the mainspring. Wind the mainspring 5 complete turns. Then place the first position of the stop on the stop works there. Be sure to double check this by winding the mainspring, with the stop works in place, while making sure you get the 10 complete turns as the stop works in this case will allow.

The quick and easy method in determining where to place the stop is to first fully wind the mainspring then "back-off" the mainspring anywhere from 1 to 3 turns or revolutions. Backing off is a controlled unwinding of the mainspring. Then place the stop wind on so that you cannot wind the arbor any further.

On the usually overpowered American and Asian movements you can back off the full three (3) turns. On the finer European movements it is generally best to stay under two (2) turns because there is much less "excess" in the mainspring.

8b) Properties for a Fusee

Many English and some other clocks use a Fusee. A fusee is a conned or fluted wheel above the mainspring barrel. This fusee wheel is connected to the main or going wheel by cable, chain, or gut. The fusee is supposed to keep the power delivered by the mainspring fairly constant as the mainspring unwinds.

This must be set up correctly by first winding the cable or gut on the main wheel. This means that the fusee has absolutely none of the cable wound on it. The main wheel has a winding arbor, a click, and ratchet. These are in place for the sole purpose of placing tension on the mainspring. The reason for this is that there must be tension as the cable winds off the fusee or the clock will stop prematurely and more importantly the cable will loosen and get tangle or interfere with other wheels as the clock runs.

In general, you wind the main wheel one to 1 1/2 turns and you're done. Make sure that the cable will wind correctly as you wind the clock. Winding take place on the fusee wheel. The cable can and will cross or miss groves on the fusee unless you watch it very closely. Once the cable winds correctly on the fusee, it will do so on its own each and every time because it will "spool" correctly onto the main wheel.

The initial set up is not as easy as it sounds because the mainspring tightens as you spool the cable onto the fusee. This tightening makes guiding the cable onto the fusee extremely difficult. When placing the cable around the main wheel try to keep good spacing between the individual "lines" of cable. While you are winding to the fusee, try your best to guide the cable before each turn of the fusee arbor and wind very slowly.

9) Repair

Most times a mainspring cannot be repaired. The exception is the hole end mainspring that has a break in the hole end. This is the end which attached to the barrel tongue or hook.

After you have removed the mainspring, hand clean the broken end to be fixed. Then cut off the end of the mainspring. I do this with a rounded cut using heavy-duty tin snips. Heat the last 3 to 4 inches of the "new" end until cherry read and let the mainspring air cool. This is called annealing and will take the hardness and temper out of the mainspring allowing you to rework it.

When the mainspring has sufficiently cooled (about five (5) minutes), file the "new" end until it is rounded and there are no burrs or sharp edges. Then start the new hole. I use a mainspring or power punch but you can use a straight centering punch and a hammer. Center your hole about one to two inches from the freshly cut top of the mainspring end. I file the punched hole to as close to the original size as possible. Even though this process shortens the mainspring somewhat it should have no overall effect. That is because most mainsprings are designed to run the clock well beyond the stated running time (day, week, etc.).

Finally, I take a fine file and make sure that there are no burrs or "edges" where both the hole and "new" end has been cut. You can go one step further and take some Crocus cloth or 4/0 emery paper and do some further smoothing.

Some prefer to harden and temper the "new" mainspring end but I find that this is an unnecessary step. That is because the mainspring end is not subject to the stresses and movements that would require further treatment but each to their own methods.

Have fun but please take great care when handling a clock mainspring.

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