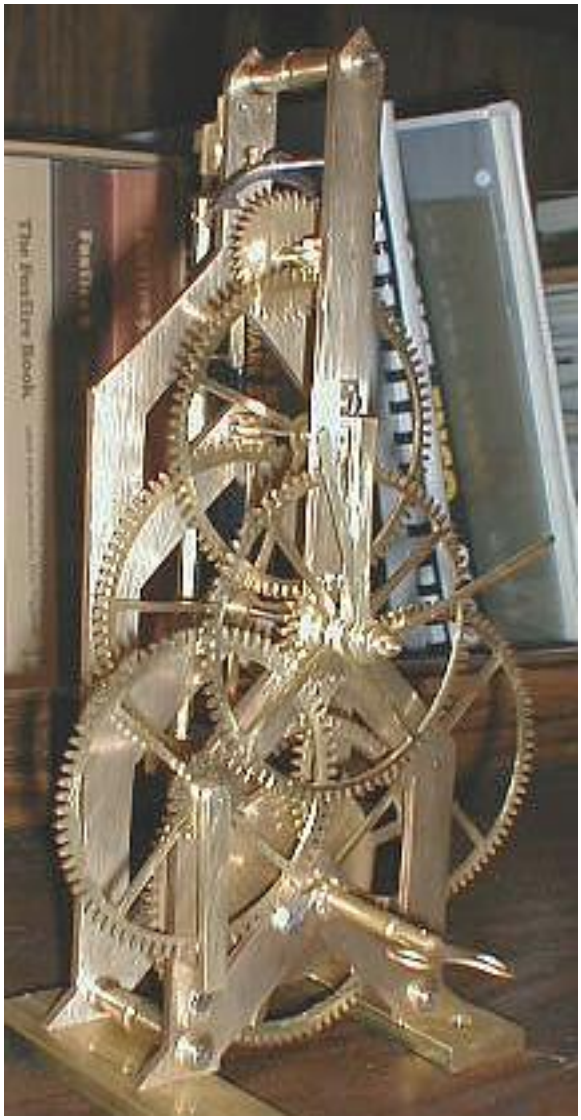
The SIN Clock



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One of my someday projects was to build a clock. Not a clock case (I've done that several times already), but a *CLOCK*. We're talking movement, dial, pendulum, case-- the whole nine yards.

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In late December, I was notified that my application was accepted, making me the SIN society's first Horologist (no, that's *not* what you think it is). For the next year, I will spend at least 3 hours a week in pursuit of my goal, which is to build a mechanical clock of my own design.

These pages will document my progress, and hopefully serve as inspiration to other aspiring clockmakers and my fellow SINners.

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Why a clock?

I was the kind of kid who was destined to be an engineer. I took apart all kinds of things (*most* of which I was able to put back together-- sorry about the toaster, Mom) to see how they worked, and was always building something or other. I don't know precisely how or when I developed this interest, but I blame it on a clock.

When I was a boy of about 5 or 6, my father (a woodworking hobbiest) undertook his most ambitious project to date: making a tall case clock. I remember hanging around "helping" while it was being built, sanding panels and marking lines with a pencil and square, but the thing I remember most was the day the movement went in.

The movement was incredible! Out of a pasteboard box came a shiny brass maze of gears, with levers and shafts and hammers sticking out on all sides. Even though I could not make heads or tails of what the parts were or how it worked, I was fascinated. When it was finally mounted in the case and started, watching it come to life was even better. The pendulum swung, gears clicked and whizzed, and hammers struck out perfect Westminster chimes on a series of steel rods.

Eventually the clock was finished and took its place in our front hall, but even then I would still occasionally stand and watch the clockworks through the small glass window in the side of the clock's head. To this day, I still sneak a peek in that little window whenever I see the clock.

Fast forward 30-odd years, and I am a fairly accomplished woodworker, just like my Dad. I have built a good bit of furniture, including several clock cases, and am constantly taking on more challenging projects. One of these challenging projects was a cuckoo clock, complete with mechanical movement. When it came time to install the works, memories of my father's tall case clock came flooding back to me. I must've actuated the chime on that movement 100 times that night (much to the chagrin of my family), watching the wheels turn and figuring out exactly how it worked.

As I was watching the movement, an interesting thought struck me-- could I *make* one of these things? I got some horology books from the library, surfed the web to find other amateur clock makers, and decided that it was not only feasible, but it sounded like it would be a blast.

Someday, I said to myself, *I will build a clock*.

So I read some more books, and started looking for antique clockmaking tools at MWTCA meets, but I never really got very serious about it. It was, after all, a "someday" project.

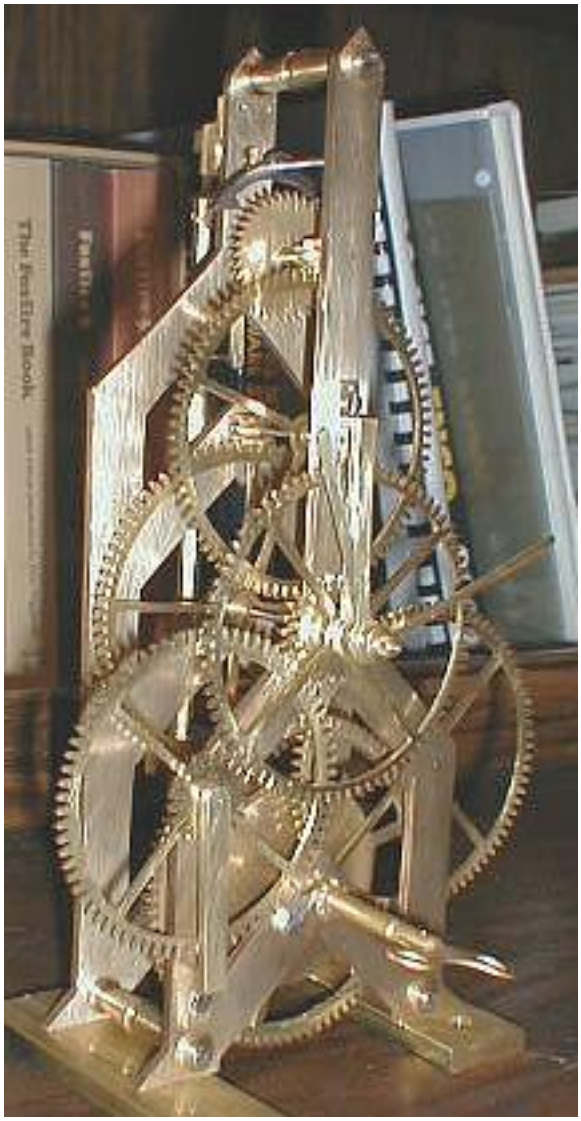
At least until the SIN Society came along...

My SIN Diary

This page documented my weekly progress (or lack thereof) towards reaching my SIN project goal. While pursuing the project, I tried to update this diary about once a week. I did pretty good overall, but there are a couple of holes.

This diary is in reverse chronological order, with the last week's report at the top.

December 1 - The End of the Road



It's finished!

It still only runs for a few hours, and it needs a case, but the clock itself is complete. I actually accomplished what I set out to do this year on the last day-- how's that for cutting it close?!

Today was pretty easy-- I made a pair of hands out of hard brass and fitted them to the motion work. I then finished up polishing the plates with some jeweler's rouge, completely cleaned all of the parts in mineral spirits, and reassembled. After adding a drop of clock oil to each of the pivots, and doing some final tuning of the escapement, off it went.

I'm still a little flabbergasted by all of this-- this project turned out to be *way* more difficult than I thought it would be, but I completed it despite the setbacks. In one year of a few hours work a week, I was able to design and build a working mechanical clock. Along the way I learned a lot about horology, precision metalworking, and also about myself.

I came to a strange realization about a month ago as I was typing up my weekly SIN report. I'm sure this was glaringly obvious to most of the other SINners, but it was a real eye-opener to me:

It's not about the clock.

Making the clock was a side trip-- something to keep me focused on an attainable goal. The *real* aim of the SIN project was in changing habits, and getting me to not be satisfied with my inner status quo. I think it's no coincidence that in the year I've been making my clock, I made several other notable changes in my life:

- I changed my exercise regimen and lost 85 pounds (so far)
- I got out of a professional rut, and love my work again
- I was elected to office in a club I have belonged to for years

as well as a host of other smaller changes...

Was this all because I built a clock? No! But what the SIN project got me to do me was shake me out of my "comfort zone", and always keep moving forward.

So what's next? I need to put aside clockmaking for a while to work on a host of woodworking and remodeling projects that have stacked up because of the time commitment I needed for SIN. I am excited about getting back to these projects (I really do enjoy the work), but a little disappointed that I won't have much clock time for a while.

I already have some big ideas for my next clock, though... ;-)

November 24 - All Over But the Shouting

My first update in two weeks-- I am still struggling to recover from my system meltdown, so I didn't get a chance to post last week's update (although I did SIN!). This report will cover the last two weeks.

Last week was spent mostly on making a pair of cocks for the motion work. The minute wheel cock (shown in the picture at right) was pretty straightforward, but the diameter of the hour wheel hole meant that I had to make the hour wheel cock from a fairly large piece and file it down. This took a lot of time, but in the end all of the parts came out great.

Once these two cocks were complete I was able to test-mount my motion work. The good news is that everything meshed smoothly, and there is plenty of power to drive the hands (which was a big concern). The bad news is that the cannon pinion was, as I feared, a little too loose. I resigned myself to make a new one this week.

During the week, however, I came up with a better idea. A common millwright's dodge for fixing worn shafts is to knurl the shaft to increase its diameter slightly. It's not a permanent fix, but it will normally hold until the new part is ordered or made. In my case, however, I am not trying to compensate for wear, I am trying to get a friction fit. Knurling the center pivot would do this, and the knurls would even help the sleeve "bite" a little better. Since the worst thing that could happen would be that I needed to make a new center pivot, I decided to take the chance and try it out.

Initial indications are that the knurled pivot will work exactly as I want it to. That's a big relief.

My other big accomplishment this week is to get all of the hand mounting hardware made. I needed to make a miniscule threaded shaft and nut to hold the hands, and square off part of the shaft to keep the hands aligned. After I made my first one, I found out that brass is *way* too soft to use for a tiny shaft like this-- When I tightened the nut, the shaft broke off! I had to make a second that used a brass sleeve holding a steel threaded shaft, and this one works perfectly.

And, yes, that *is* a dime in the picture...

My last big accomplishment for the last two weeks was to get the basic polishing of the plates done. They are still a little scratchy, though, so it's going to take a bit more elbow grease to get them really nice.

So, what's left? Finish off the polishing, and make/mount the hands. The hands I ordered are not going to work without some major modifications, so I decided I will make my own hands out of hard brass (which I like the look of better anyway). Once that is done, I will declare myself a SIN graduate, and start on the case.

November 10 - More Fun with the Motion Works

This week I spent my time working on the motion work. I got the two large wheels crossed out and polished, and made the various pivots. The pivot for the minute wheel was a real challenge, as it was only 13 mm long. It was fairly tricky working that close to the chuck, but it went quite well.

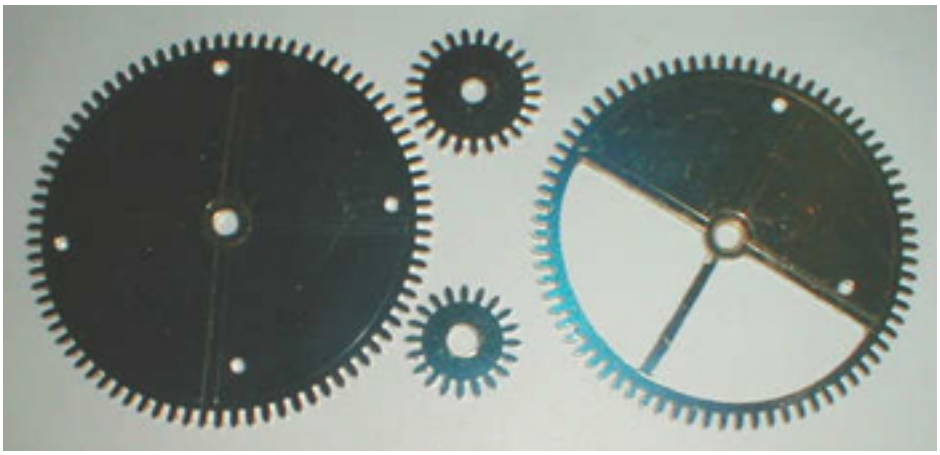
The *real* hard part this week, though was the cannon shaft. This is the tube that the cannon pinion rides on, which transfers the rotation of the center wheel to the motion work. The trick with this, though, is that in order to set the clock it needs to be able to rotate without moving the center pivot. This means you need a friction fit, which is quite difficult to achieve.

In order to get the right fit, I drilled the hole slightly undersized, and reamed to fit. My first two attempts ended up too loose (there's a *very* fine line between "won't fit" and "too loose"), but my third one should be OK. I'd like it to be a tiny bit tighter, but we'll see how it works.

The only parts left to make are a pair of cocks to hold the hour and minute wheels in place (since they ride outside the plates). I should be able to finish those next week, and mount the motion work. I have also ordered a set of hands (which will require some work on the cannon shaft to mount) which should be here next week. All that wil remain from that point on is to polish and lacquer all the parts and build a nice case for it.

November 3 - The Motion Works

This week I managed to get a great start on the last complex piece of the clock-- the motion works. The motion train is a series of four gears that mount on the *outside* of the clock plate, which convert 12 turns of the cannon pinion (which the minute hand is attached to) into 1 turn of the hour wheel (which the hour hand is atached to).



The photo shows this week's progress. I have cut all of the wheels, milled teeth into them, and have started crossing out the two large wheels. Once all of the wheels are finished, I need to make the cannon and hour pinions.

The cannon pinion is going to be pretty tricky, since in order to allow the clock to be set it has to be a friction fit on the center pinion. If it is too tight a fit the clock will be difficult to set (and it may damage the hands/gears), while if it is too loose it will slip and not keep accurate time. Given my track record with new stuff, I'd wager it will take 3-4 attempts before I get one that works.

Also new this week, I have created CAD drawings for the motion works, and added them to the web site. I've been a busy boy...

October 23 - The Creature Breathes!

At about 10:00 p.m. tonight, I finished the new escapement. At about 10:05, the clock ticked its first beats with the new escapement. By about 10:15 I had adjusted the anchor position to the point where it would tick evenly.

IT STILL DIDN'T RUN.

When I removed the pendulum, however, a marvelous thing happened-- the clock started ticking on its own! The crutch was acting like a tiny pendulum, beating a wild tempo, but it *RAN*. I watched it for about 5 minutes and it didn't show any signs of slowing. After removing some weight from the pendulum bob, I re-added the pendulum and tried again. Voila!!

Tick, tock, tick, tock...

That was two hours ago. It's been running since-- I know because I watched every tick. I haven't put it into beat yet, so it's not keeping anywhere close to correct time, but it is running smoothly and ticking evenly. There's still a lot of small stuff to do, but now I know it's actually going to work

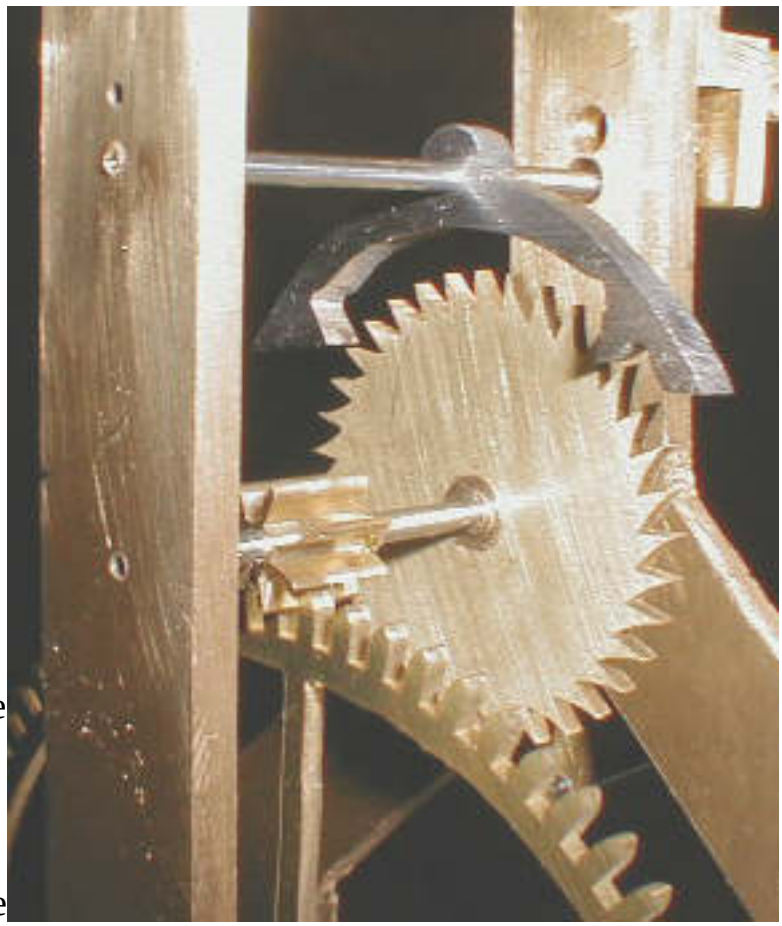
In case you can't tell, I am truly amazed. My clock is running. The clock I *made* is running. Wow. I don't think I'll be able to sleep tonight.

Someday is now.

October 20 - Progress, but not there yet

My first update in two weeks, since I was out of town for 5 days last week (MWTCA national meeting and a college trip). I managed to get a little SIN done during the week, and this weekend I declared a SIN-a-thon, with over 12 hours spent on the clock.

The bad news is the larger anchor did not fix the problem. I was able to get the clock to run for a quite a bit longer, but I discovered a new problem. With the larger span, the margin for error in the "drop" is far smaller-- this means that there's not as much time between when one pallet releases a tooth and the next one catches it. The escape wheel I had been using had "blunt" tips to the teeth to make them stronger, but the extra width of the tooth did not give enough time for the anchor to drop.



In non-technical terms, I had to make a new escape wheel with narrower teeth.

The picture at right shows the culmination of the last two week's progress. In order to get rid of the blunt tips I had to cut the new wheel about 1.5 mm smaller than the old one, which meant that I had to also make another new anchor (up to 4 now), and re-plant the anchor pivot closer to the escape wheel. I still have a lot left to do before I can test it, but hopefully sometime this week I will be able to see if this does the trick.

I am actually fairly confident this time around. I've completely remade the escapement 4 times now, and each one has gotten a little better. I've learned a lot along the way, and think I now *truly* understand the mechanics I am dealing with.

I am still hoping to get the clock running by the end of the month, but if this iteration doesn't work I doubt I will be able to. Even with all of the overtime I have put in this month, the fact that I need to do about 12 hours of work for each trial makes it hard to catch up.

October 6 - Back to SINning!

I ended up having to take a hiatus from SINning because of the work concerns mentioned in my last report-- I ended up doing 11 straight days of 16 or more hours, including 3 all-nighters. I love my SIN project, but at that point sleep was more of a priority! ;-)

The worst thing about my "death march", though, was that it forced me to miss the SIN picnic. I

had cleared a couple of hours to spend at the picnic, but work called me in early because of a problem. Bummer. I had something to show, too-- a clock that would run for 3 minutes.

Getting back to normal this week allowed me to catch up on my missed SIN time. I did a total of 12 hours of SIN this weekend, but really don't have much to show for it yet.

I have been working on getting my clock to run for longer than a few minutes. After consultation with my dream team, I had a lot of things to try. I tried a heavier pendulum, thinner spring, stronger spring, oiling the pinions, thinner pendulum rod, and repolishing the anchor. Of all of these, only repolishing the anchor had any significant effect. With buffing my anchor all the way down to 8000 grit chromium oxide powder, I was able to get the clock to run for about 7 minutes.

My last resort was a suggestion from a horologist in England, who told me to widen my anchor to span two more teeth. Supposedly this will give more impulse to the pendulum. The layout of this larger anchor was a bit tricky, but I managed to get it laid out and cut this evening. I have a LOT of filing left to do on it, and then the same fitting and polishing I did on the old anchor. Hopefully by next week I'll know if this will do the trick.

Once the clock is actually running, there's not much left for me to do-- All that's left is to make the motion work and polish the plates. Even with this setback, I am still on track to finish by 12/1 (provided the new anchor actually works!).

September 22 - It WORKS! (barely)

My first report in two weeks. Work has gone completely nutso (we release a week from tomorrow), so I have been putting in 16+ hour days and have not had much time to dedicate to SIN. I did manage to get at least a couple of hours in the last two weeks, though, and have made some progress.

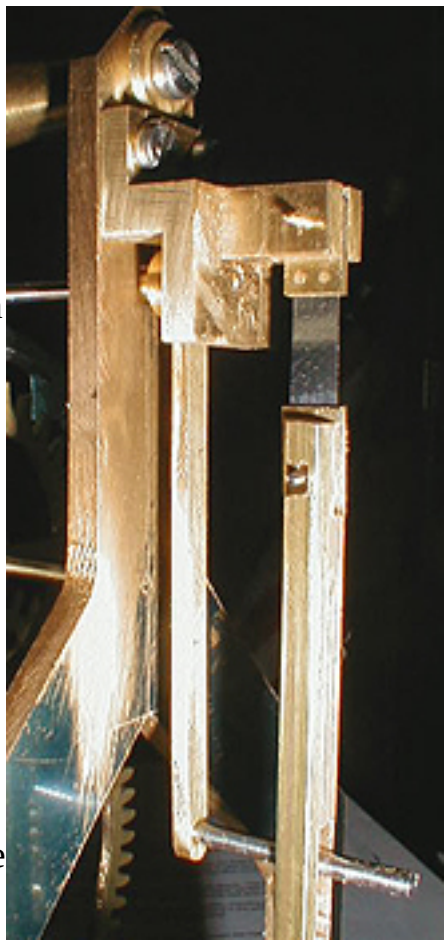
In the last two weeks, I made a temporary pendulum bob to test with, and finished off the clickwork for the barrel. The click turned out to be a lot trickier than I imagined it would be-- I needed to make several before I finally got one that worked OK.

The monumental announcement for this week, however, is that about an hour ago, my clock actually ticked! It was pretty amazing to wind it up, take a deep breath, give the pendulum a push, and just watch everything work. A few months ago I thought I would never see this day.

The bad news is, it only runs for about 30 seconds before stopping.

I have a mail into my dream team for advice, but my guess is that I will need to add more weight to the pendulum, and perhaps use a less "beefy" suspension spring. I'm hoping to get a little time to play with it before the picnic, and hopefully get it to run for at least a few minutes. We'll have to see!

September 8 - The Pendulum Rod



My suspension springs came this week, so I was finally able to start on pendulum itself. First up was mounting the spring to the back cock, and making a pendulum rod.

The picture at right shows this week's progress. You can see one end of the spring has been mounted to the back cock using a small brass pin, while the other end fits into a slot filed into the pendulum rod. A little further down, you can see where the crutch arm fits into a slot in rod, allowing the pendulum swing to be transferred to the escapement.

It all looks so easy when it finished... ;-)

The pendulum rod was a real comedy of errors. The one you see in the picture is acually the *fourth* one I made. The first one I screwed up the slot for the suspension spring (off center), the second I did not drill the hole for the suspension cross-pin in the correct place, and on the third one the drill wandered while I was cutting the slot for the crutch.

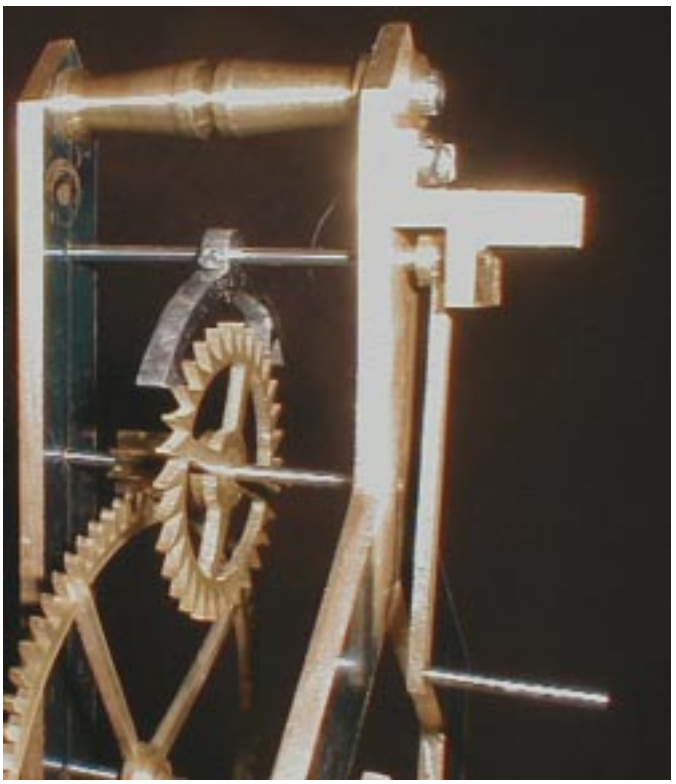
Even the "good" fourth piece has got a little chunk of broken 1mm drill bit embedded in the rod-- the slot for the crutch is supposed to be slightly longer. Since the length of the slot really doesn't matter so long as it does not impede the swing of the pendulum, I decided to live with it.

Next up I need to make the clickwork for the barrel, so that I can wind the clock to test the pendulum. At one point I had a ratchet wheel for this, but I have now misplaced it. I will need to make a new one (pretty easy), as well as a ratchet click (the part that prevents the ratchet wheel from turning backwards) and spring.

It's going to be tight, but I think I can have this ready for the picnic...

September 1 - Getting Ready for the Pendulum

Busy week this time-- I fixed last week's mistakes, and made some pretty good progress. With the long weekend, I also got to spend a little extra SIN time, which helps!



This week I placed an order for the remaining parts I need for the pendulum (suspension and click springs), so I spent my SIN time doing the final parts of the movement. First up was fixing the escapement pinion I ruined last week. By now, I am getting pretty quick at making pinions so this went fast.

With the escapement working again, I turned my attention to the the last piece of the going train-- the crutch (shown at right). This piece is attached to the escapement anchor pivot, and is used to transfer the swing of pendulum to the anchor. The steel rod sticking out will fit into a slot milled in the pendulum. This was a pretty easy part to make, but it required a LOT of filing...

My other major accomplishment was to *finally* finish the barrel. The metalwork has been done for some time, but I needed to drill and tap for a tiny screw to engage the end of the mainspring, and wind and mount the mainspring itself.

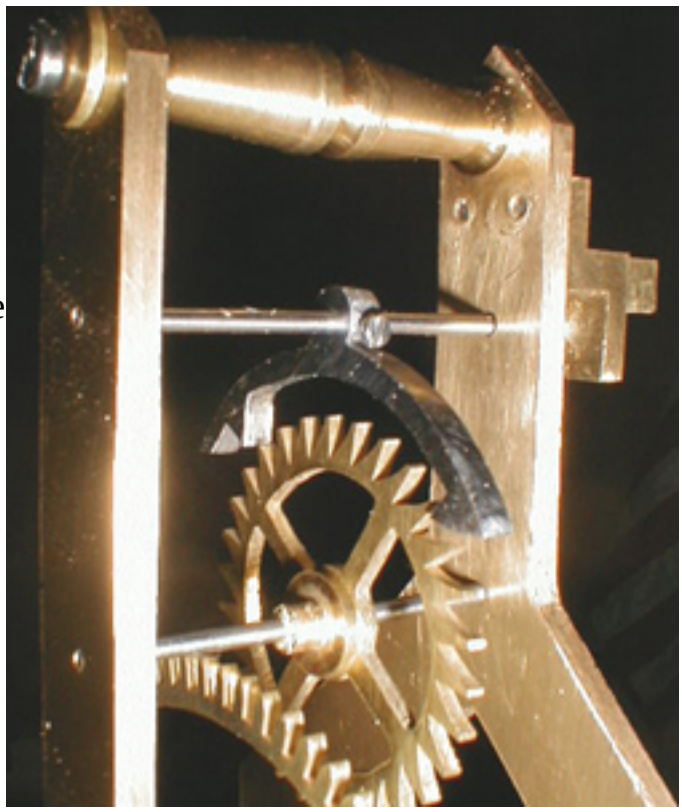
Working with a clock spring is a dangerous and scary thing-- there is a *lot* of power stored in one of these, and if it "lets loose" it can cause serious injury. Since this is my first time working with one of these, I was extra cautious. Using my 1890 Vaughan's patent mainspring winder (you know I had to work an antique tool into this project somewhere) I carefully wound the spring and tried to insert it into the barrel. No luck! It turns out that my barrel is about 3mm too deep for the winder to insert the spring.

After slowly letting down the spring, I consulted my old horology books looking for hints, and found a good description of hand-winding the mainspring. This turned out to be a lot of work, but I eventually got it all into the barrel. Unfortunately, I got it all in the barrel backwards! After removing the spring, I rewound it in the other direction and all was well. As you can see by the picture at right, I eventually succeeded!

Next up is the pendulum and clickwork. As I said, I placed an order for the remaining parts I need, so they should be here this week. I need to do some experiments with the pendulum length and weight, so it'll probably take a couple of weeks before everything is ready to go. I am aiming to have a running clock for the picnic at the end of the month-- I hope I can make it!

August 25 - The Escapement Lives!

Well, a typical week for me-- one big step forward, one smaller step back...



As you can see in the picture at right, I managed to get the entire escapement mounted. I had to make a new pivot for it (well, 2 actually-- the first broke) because the old one I made turned out to be a little to short to fit the back cock. That was the easy part, though.

My real concern this week was tapping the screw hole in the anchor. If you look carefully at the picture, you can see a small "bump" on the side of the anchor where the shaft runs through. This is actually a *tiny* screw-- 1.6mm in diameter, and only 3mm long! Given the problems I had last week tapping something nice and soft like brass, I was *really* nervous about this piece. If I broke the tap on this one, about 6 hours work was destroyed-- there would be no recovery possible.

Needless to say, it worked. What a relief! I think I may have set a record for the slowest tapping job ever, though-- I spent about 20 minutes just tapping this hole. I worked really slowly, and used a LOT of cutting oil, but at least the tap came out in one piece.

As usual, however, in order not to upset the cosmic karma that this project has developed, since something went right, something else had to go wrong... ;-)

Once I got the new pivot and anchor mounted, I was finally able to mount the escape wheel (which had been loose). When riveting the wheel in place, however, the part slipped on my anvil and I ended up breaking one of the pinion leaves. It's a pain that I have to make yet ANOTHER escape pinion, but I'd much rather remake a pinion than the anchor!

August 18 - The Back Cock

I thought after finishing the anchor last week, I'd be able to coast for a bit and make some easy parts. Boy was I wrong!.

The picture at right shows this week's progress-- the "back cock" for the clock. This is the piece the pendulum hangs from, and also allows the anchor pivot to get outside the plates so that it can connect to the pendulum.

The piece itself was milled from a chunk of brass bar, and filed to precisely fit the plate. It is mounted to the plate with a pair of 6mm long screws, and that's where the trouble began...

I got all of the holes marked out and drilled just fine. I decided to go with 2mm screws to attach the cock, so I drilled the plate accordingly. First hole went perfectly, but when tapping the second hole the tap snapped off almost perfectly flush. There was nothing to grab onto to remove it, so after muttering a nice string of expletives I came to the conclusion that the only thing to do would be to drill it out.

After drilling it out to 4mm and putting in a patch (a chunk of 4mm brass rod filed flush), I decided to go with a slightly beefier 2.5mm screw. So I redrilled the plates for the larger size and went at it. Again the first hole went perfectly, but *AGAIN* the tap broke while cutting the second hole! This time there was about 2mm sticking out, so I was able to grab that with vise grips and pull the broken tap through.

When all is said and done, I am probably the only person who will ever notice the patch, but it's still depressing. Up until now every screwup was recovered by making a new piece, so the clock itself had no physical flaws (just don't look in my scrap box). This repair won't affect the timekeeping at all, fortunately.

I was hoping to also get the anchor pivot mounted today, but that will involve some tapping. Given my track record this week, I think I'll leave that for next SIN session...

August 11 - The Anchor

This week I made the most difficult part of the clock so far-- the escapement anchor. I'm not quite done with it yet, but it's pretty close.

The anchor is probably the most "fidgety" part of the whole clock. It must run smoothly, since even the tiniest sticking will stop the clock. It also must be made very precisely, since the geometry of the anchor provides the push that keeps the pendulum going.

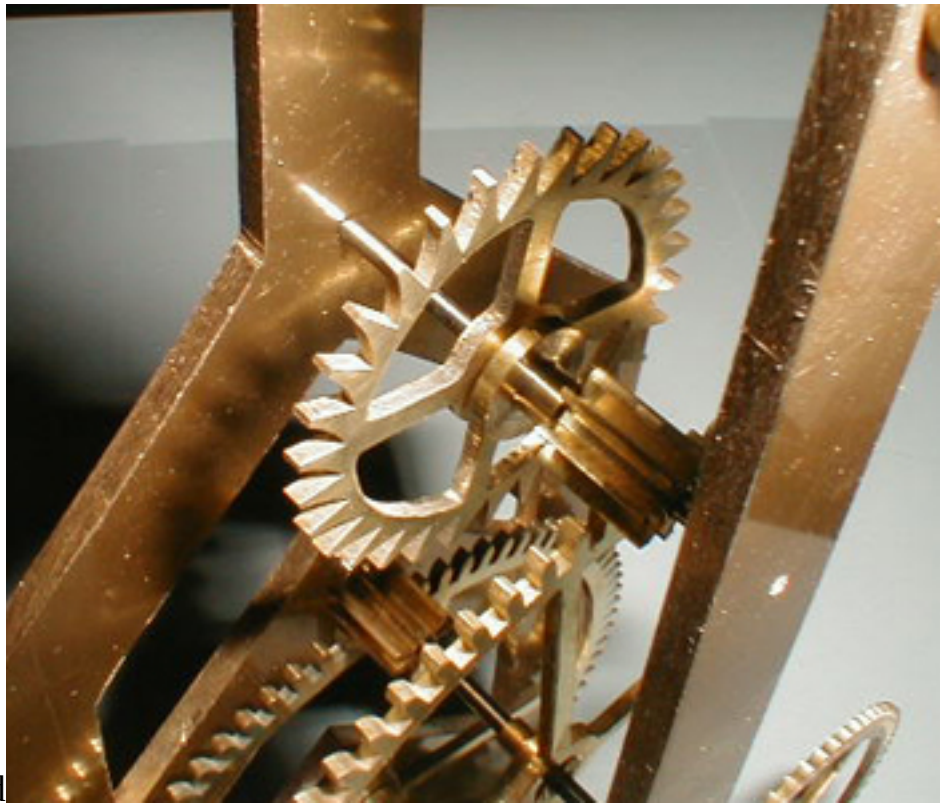
Marking out the anchor is a trick unto itself: I am using the "Gazely Method" as outlined in Guy Lautard's book, which involves a lot of weird angles and measurements. It took me at least an hour to just lay out the part.

Cutting was another real chore. 3mm thick steel does *not* cut very well with a jeweler's saw. After breaking a couple of dozen blades going the first mm or so, I decided to line-dril the rough profile and file it to size. This worked much faster, and in the end was probably more accurate, so I'm glad I did it this way.

After cutting the piece, I spent nearly an hour fine-tuning the pallets so that they would *just* pass the wheel. The picture at the right shows the anchor and escape wheel mounted in my depthing tool to test the "drop" of the pallets. I now have them adjusted such that the drop is at an absolute minimum. I will not take it any further until I get the parts mounted and the pendulum installed so I can test whether I have left enough clearance. Once everything is perfect, I will harden the pallets and polish everything to a mirror finish (to reduce friction).

Next up is to make the back cock-- this is the piece that the pendulum will swing from. It is also the piece that holds the back of the anchor pivot, so until this is made I cannot plant the anchor pivot.

August 4 - Recovery



This week actually went fairly well, which was a real relief.

I managed to recover from last week's debacle by making a new pivot, pinion and collar for the escape wheel. I made the pinion about .1mm smaller in diameter for make up for my misplaced plant last week, and it actually worked pretty well. The clock now runs smoothly again, and will "coast" for about 15 seconds when you stop pushing (indicating low friction).

The picture at right shows the escape wheel in its real position in the clock. As you can probably guess, it's not mounted yet! I learned that lesson the hard way, and won't soon forget it.

Next up is the pallets and anchor. This is going to be a somewhat finicky part with fairly high tolerances, so I am going to take this one *very* slowly. This will also be the first time I have had to cut steel with the jeweler's saw (3mm steel, no less), and I'm not particularly looking forward to that either.

The good news is, though, that once the anchor and pallets are made, the going train is complete! I will only have to make the pendulum and mount the mainspring to have a sorta-functional clock (minute hand only).

July 28 - And the week started off so well..

It's been a while since I've had a serious problem, so I should've known I was overdue. Flush from my euphoria from the SIN meeting on Tuesday, I attacked my Sunday SIN time with as much energy as I ever have. Unfortunately, the energy dissapated quickly as I discovered my first screwup.

Since I was in such a rush last week to have *something* to show at the SIN meeting, I made a serious blunder. So that I would have something that "worked" I attached all of the wheels to their pivots. What I neglected to consider, though, was that I had not planted the final pivot-- the one for the escape wheel. While polishing the escape pivot I came to a sudden realization:

I ATTACHED THE WHEEL-- I CAN'T USE MY DEPTHING TOOL!

That's right, in my haste I forgot that I was not finished marking pivot locations. With the third wheel attached, I could no longer use my loose wheel depthing tool-- I had to improvise. With a bit of ingenuity I managed to get the wheel depthed, but it turns out that the way I did it was not quite as accurate.

To make a long story short, I ended up planting the escape pivot about .05mm too close to the wheel, which meant that when I attached the pinion it bound every so slightly. The further you get from the power train, the less force it takes to stop the wheel, so this tiny binding was enough to make the entire train stuck.

Fortunately, it's not an insurmountable problem (despite what it felt like at the time). I need to remake the escape pivot, and cut a new pinion of a slightly smaller diameter. It might take me a piece or two to get the size exactly right, but it's going to be way better than remaking the plates!

Also, being the start of a new month, I need to set my goal for August. It's going to take me a week to recover from this screwup, but I'd really like to have a running clock to show at the SIN picnic in September. I'm going to set the aggressive goal of having the entire escapement working and the mainspring mounted by the end of the month. If I can do that, I will only need to make the pendulum before the SIN meeting to have a quasi-running clock.

It'll be tough, but I'm going to try!

July 23 - SIN Meeting

Tonight, I schlepped all the way up to Park Ridge for the SIN meeting, and am I ever glad I did! I missed the last one, so I hadn't seen my fellow SINners since early spring. A LOT has changed since then.

Hearing about others' successes and failures really helps me focus on what I am trying to accomplish, and energizes me to do better. After all, I don't want to let the SINners down!

Thanks EZ. None of us could've done this without your prodding!

On my personal SIN front: I really wanted to be able to show something that clicked and zizzed at the SIN meeting, so this week I concentrated on mounting my wheels and polishing the pivots so that the clock would "run" when you pushed a wheel.

Everything went pretty smoothly-- The only snafu was I had to shorten two of my pivots by a couple of tenths of a mm in order to get them to run smoothly. This went without a hitch, though, and the movement ran exceptionally well when I tried it for the first time. What a relief!

I also managed to cut a smaller escape wheel (37mm diameter instead of 43mm), and this one looks like it might work. I may cut one more slightly smaller one just in case. We'll see how much time I get this week.

July 14 - More Wheels

Since the catalog order I placed for a pivot file and polishing compond has not arrived yet, I was unable to do much more with planting the wheels this week. This meant I needed to concentrate on my other goal for the month-- the escapement.

I made two wheels this week-- the escape wheel, and a small ratcheting wheel for the barrel. Both of these wheels use non-standard teeth. The escape wheel uses a curved tooth to provide the "recoil" needed by the pendulum, while the ratchet uses a plain triangular tooth.

You can't quite see it in the horrible picture I took, but the ratchet wheel has a square hole. This fits the winding shaft on the barrel pivot. The ratchet will ride against a spring loaded "click", ensuring the barrel only turns in one direction. This allows you to wind the spring, but prevents the barrel from unwinding it other than by powering the drive train.

Both wheels went pretty well, but the escape wheel used a different kind of cutter, which caused me some problems. It took a couple of experimental cuts to get the hang of using this style of cutter.

In looking at the escape wheel I made, I am a little concerned about the width of the tips of the teeth. If these are too wide, it could make the clock not run as smoothly as it should. I may make another smaller wheel to see if that will work better.

July 7 - Planting Wheels

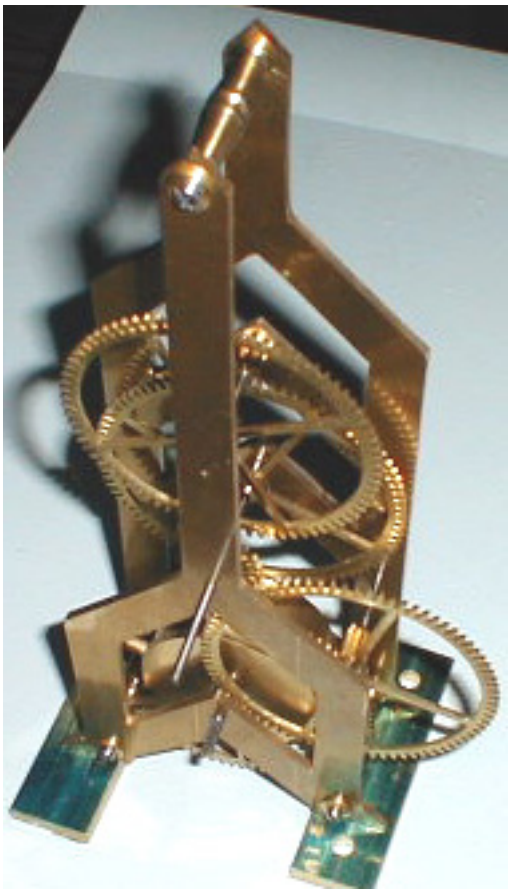
It's hard to believe I am at the halfway point of my SIN project. It's been a great experience, and I still really look forward to my SIN time. I am on track to complete my goal with time to spare, which really makes me proud.

This month begins with planting the wheels I have made. "Planting" is the clockmaking term for actually drilling the holes in the plates for the pivots to ride in. This is perhaps the

highest-precision step in the whole operation-- the holes must be located such that the gears mesh smoothly.

It all started with the center pivot hole. The plates were screwed together using some special shafts that fit the pedestal holes, and the position of the center hole was measured and drilled. The holes were drilled undersize, and carefully reamed to fit the pivot exactly.

Once the center hole was ready, the center pinion and 8-day wheel were placed on the depthing tool to determine the proper spacing for them. Once they meshed smoothly, the depthing tool was used to mark the proper location of the 8-day pivot, and it was drilled and reamed.



This operation was repeated with every wheel/pinion combination until all of the plate holes were drilled. The picture at right shows the planted wheels loosely mounted in the plates. It's starting to look like a clock!

Much to my relief, all of the holes were drilled accurately, so the gears mesh smoothly and should run well. As usual, however, there were a couple of things that didn't quite work.

When I mounted the wheels for the first time, the 8-day wheel would not turn. My first thought was that I had mis-planted it (which would have meant re-making both plates), but it turns out that it was hanging up on the barrel pivot. I knew this would be close from my CAD drawing, but it turned out to be *too* close. Luckily the fix was simple: I just turned down part of the barrel pivot shaft a bit, and everything works smoothly.

The second surprise came when I mounted all the wheels and tried to stand the clock up. It turns out that the barrel wheel extends a bit beyond the bottom of the plates, so I am going to have to mount some feet to raise the plates a little bit. Again, not that big a deal, and easy to work around.

The wheels are currently "loose"-- the collars are not soldered to the pivots yet, and the wheels have not been riveted into place. That's my task for next week...

June 30 - More Toolmaking: A Collet Box

The collet box turned out to be a pretty straightforward, but it did take all of my SIN time for the week. I made it out of some scrap cherry I had lying around, and finished it up with a couple of coats of orange shellac.

Since I've been in metalworking mode for so long, it was fun to do a quick woodworking project. The box itself is about 8" x 6" x 2-1/2", and has space for 99 collets. That should hold me for a while, despite my rapid accumulation of these...

Being the end of the month, my other big concern is what to set as next month's goal-- I'm sure I'll have a mail from EZ any minute now.

The obvious next step now that I have my depthing tool is to plant the wheels I have cut so far, so that will be part of my goal. I don't think that will take the whole month, though, so I am also going to try to cut the escape wheel and pinion. If all goes well, I may actually be able to cut the escapement pallets as well. We'll see!

June 23 - Depthing Tool completed!

I didn't get a lot accomplished this week for various reasons, but I did complete my goal for the month-- I now have a nice and fully functional depthing tool!

Since I am in "make-a-tool" mode and I still have a week to go in the month, I am going to use the extra time to make another thing that's been bothering me-- a collet box. I have acquired quite a number of WW collets (used for holding very small parts in the lathe), and storage for them is getting to be a problem. I will use the extra time this month to make a nice box to hold and organize them.

June 16 - The screw from hell

This week I spent all of my sin time making a single part, and I didn't even finish it. The picture at right shows my depth tool with it's new screw adjustment feature. As you can see, I still need to cut off the excess rod and knurl the screw head, but the hard part is done!

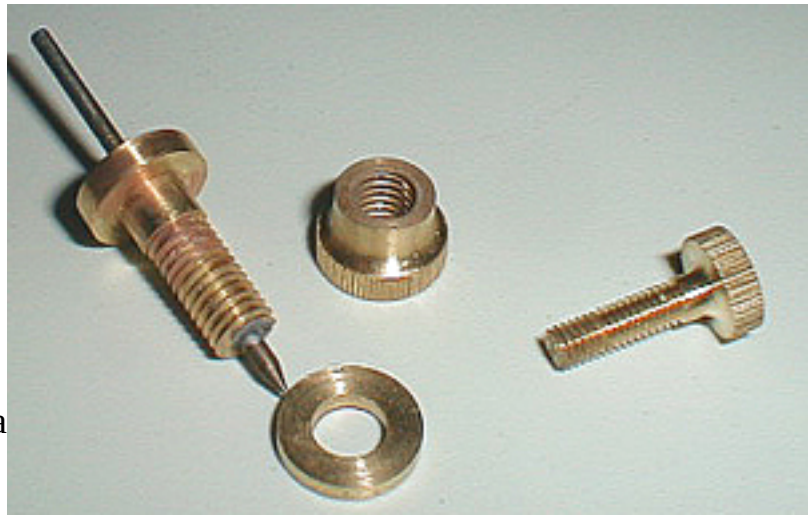
This piece was *nasty*! What made it difficult was that I had to cut and thread a long and slender piece. The threaded part of the rod is 4mm in diameter and about 60mm long, which meant that when I tried to cut it the center would deflect. This left me with a non-uniform diameter, which is

obviously a problem with threaded parts. Light cuts and multiple passes were the order of the day.

In retrospect, it would've been much easier to just buy some threaded brass rod and put a knurled head on it, but what's the fun in that? ;-)

The good news is the depthing tool went together very well, and I will be finished with it with only an hour or so more work. Since this was my goal for the month, I am well ahead of schedule. I don't quite know what I will do with my extra time yet, but I'll try to figure something out this week.

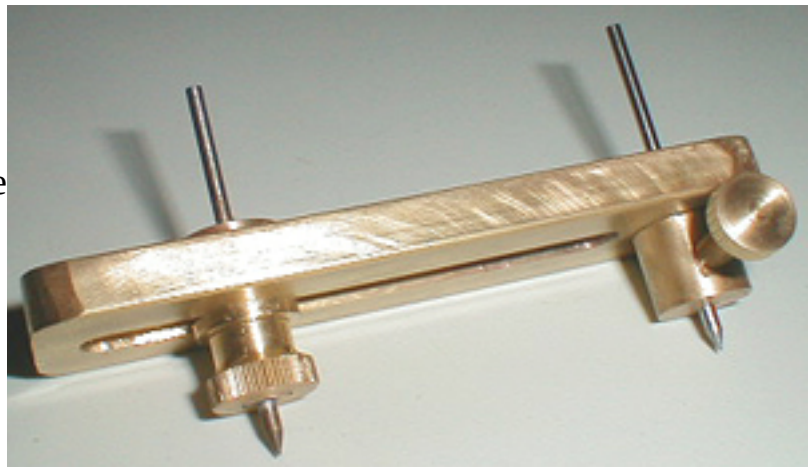
June 9 - Screw cutting!



Another fairly monumental achievement this week-- I cut my first screws. As usual, I completely botched my first attempt, but went on to recover nicely.

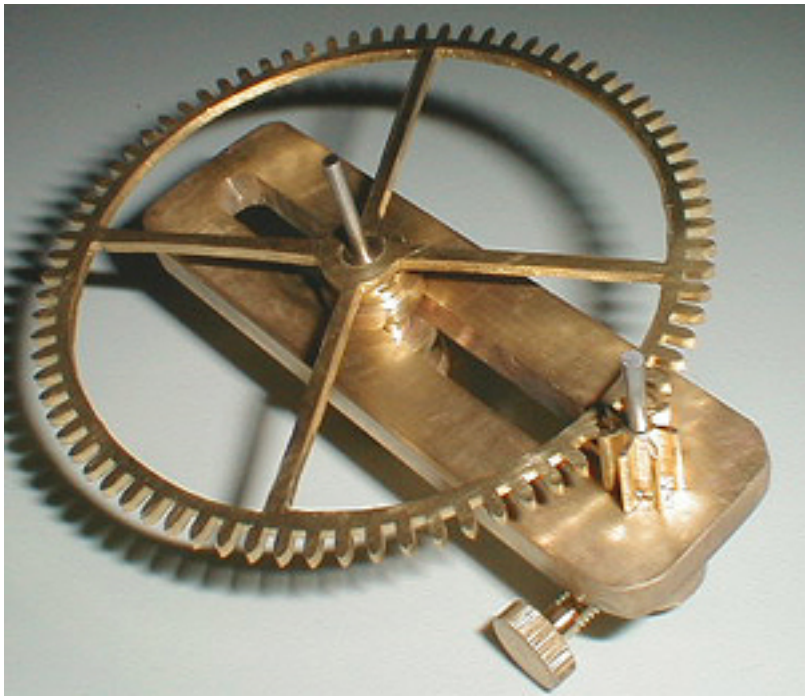
The picture at right shows my adventures in thread cutting. The three pieces on the left make up the sliding post for the depthing tool, while the screw on the right is to hold the fixed point. The sliding point is cut with a 6x1 metric thread pitch, while the thumbscrew is a much smaller 4x.7 pitch.

The thumbscrew in the picture is actually my third attempt-- the first failed because I cut the threads too deep, and the second failed because I mis-read the setup for my desired thread pitch and used the wrong change gears. The third one came out really nice, though. Armed with the knowledge of my screwups, I cut the threads in the post correctly first time out!



With these parts I have a usable depth tool, but the tool as it stands is not the best. The problem is that it is very difficult to do fine adjustments without losing the position of the sliding point. Even tightening the screw will sometimes move the pin out of alignment.

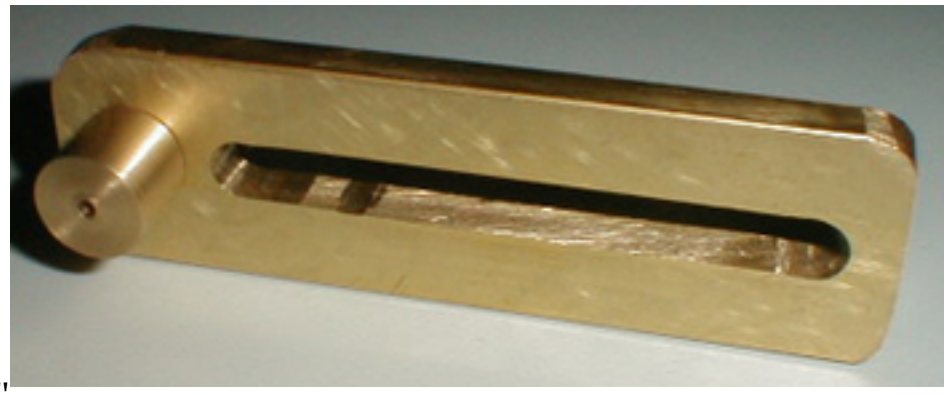
The best quality commercial depthing tools used a threaded rod to adjust the sliding point. This way, the adjustments are precise and controllable. Since the tool acutally went together fairly easily so far, I am going to tempt fate and add a screw adjustment for the sliding point. Even if I totally screw up, I will still have a usable tool, so I'm not too worried about it.



Lastly, a finished shot of the depthing tool in action. Note that a pinion has been mounted on the fixed point, and a wheel (fitted to a collar that fits the rod) mounted on the sliding point. The sliding point is moved back and forth until the wheel and pinion mesh perfectly. The fit of the two can be tested by spinning the wheel with your finger.

Once adjusted to the proper depth, the motion will be smooth and noiseless. At that point, the two sharp points on the depthing tool can be used to lay out the location of the pivot holes on the clock plates.

June 2 - Making a depth tool



This week I started on my depthing tool. A depthing tool is used to set the distance between a wheel and pinion very precisely, and transfer that distance to the clock plates for drilling. There are two flavors of depth tool commonly used-- one that works on wheels mounted on pivots and one that works on "loose" wheels. The former is used mostly in clock *repair*, while the latter is used for clock *building*. I am making a loose wheel depth tool.

As you can see from the picture, there's not much to look at yet. The body of the depthing tool is a piece of 1/4" thick brass, about 1" wide and 3-1/2" long, with a 1/4" wide slot cut down the center. The cylinder on the end will hold a fixed point, while a moving point will eventually run in the slot. If I decide to get *really* fancy, the movable point will be finely controlled by a threaded rod running the length of the tool.

One of the real challenges on this tool is that I need to make my own screws for it. Commercial screws are not available in the size and configuration I need, so I will need to turn the screws on the lathe, cut threads in them, and knurl the heads. None of it is rocket science, but I'm still a little nervous about it...

May 27 - Crossing out

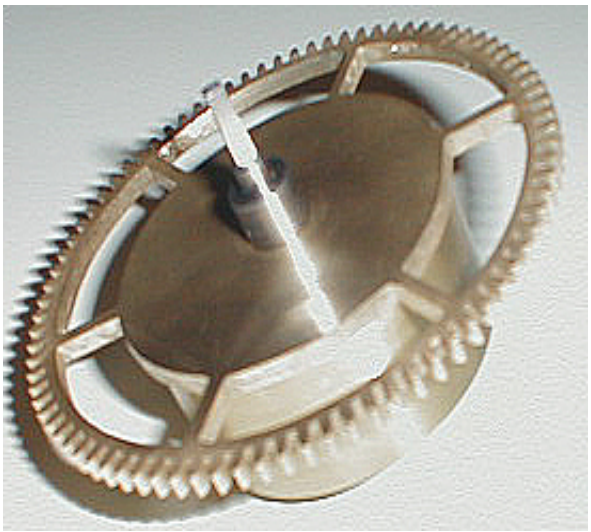
This month started off rough, but in the end was perhaps my best month yet. Not only did I manage to hit my stated goal, but I was able to extend it and gain back some of the time I had lost earlier.

The picture at right shows my progress for the week. As you can see, I have all three of my "big" wheels (center, third, and 8-day) completely crossed out and all of the related pinions cut. The crossing out on these thinner wheels (1.5mm thick) was significantly easier than the 3mm barrel, so the work went fairly quickly. I still broke a lot of blades, but my technique really improved as I went along-- the last wheel needed only a little filing to make it hit my layout lines.

Since my stated goal was only to have the teeth cut in all of these, I'd say this was a successful month! For June, I am going to switch gears a bit-- the next big task is to depth and plant the wheels, so I need to make a depthing tool. This is a special tool that allows you to accurately set the distance between two gears, so that the teeth mesh smoothly. You can buy these but they are very expensive, so I will be making my own.

Should be an interesting change of pace...

May 20 - More progress



Another great week! Nothing major went wrong, and I made such excellent progress I have extended my goal for the month.

The picture at right shows my major accomplishment for the week-- I finished crossing out the barrel wheel, which basically completes the barrel. The only thing left to do is final polish and lacquer, which will happen at the very end when everything is fit together.

I decided to do the barrel first, since it is the hardest. Not only are there 6 spokes instead of the usual 4, but this is the only wheel made from the thick 3mm brass. I broke a *lot* of blades crossing this one out (probably 30 or 40 in all), but it's done and the rest will be much easier!

Since things are going so swimmingly right now, I am going to try to extend my goal for the month. Now I am not only going to have the four largest wheels in the clock cut, but I am also going to have all four of these wheels crossed out and rough polished. At the end of the month, I

should hopefully have the entire power train and going train (sans escapement) ready to depth.

May 12 - "Slow Down and Go Faster"

Early this week I talked with a horologist (one of my dream-team members) to ask for advice on eliminating the wolf-tooth problems with my pinions. We traded emails for a couple of days, and he gave me lots of help and advice.

When I mentioned how slowly my wheel cutting was going, however, he was incredulous-- he could not believe I was spending 4 minutes per tooth. I explained my experience with cutting the barrel teeth, and we talked in detail about problems and techniques.

It turns out, I did three things wrong with the barrel: I crossed it out before cutting the teeth, I used aluminum instead of brass for the cutting arbor, but most importantly I needed to, in his words, "slow down and go faster".

Most of my vibration problems were caused by using too high a cutter speed, and feeding too slowly. When I slowed down the cutter to about 300 rpm, and increased my feed rate, everything went *much* more smoothly. There was still a little "ring" while cutting, but the vibration was dramatically reduced, and I was able to cut a tooth in about 30 seconds.

The end result is that I was able to cut the teeth in my two remaining wheels (80 tooth 8-day wheel and 78 tooth third wheel), and even re-make the barrel wheel that I screwed up previously. With the new techniques, it was actually *fun* to cut the wheels instead of stressful!

All is not sunshine and lollipops in horology-land, though-- I still have not successfully cut a 7-tooth pinion. I made three more attempts this week, and while they were way better than my first attempt, they still have some pretty wolf-y teeth. Armed with some new advice, however, I am confident that I will have all of these done in the coming week.

With my newfound knowledge and techniques, I am now pretty far ahead for the month. I have only to make two 7-tooth pinions to reach my May goal, which should be a piece of cake. I will use the extra time to try to "finish" the wheels, i.e. get them fully crossed out and polished. I also need to make a couple of new pivots to accomodate the smaller-than-expected pinions.

What a great week!

May 5 - More Adventures in Wheel-Cutting

I was determined to successfully make a wheel this week, so I spent a lot of extra SIN time-- about 6 hours total this week. The good news is, it paid off! As the picture at right shows, all 84 teeth in the center wheel were cut, and when I got around to the last tooth (where I would find out if anything slipped) it was *perfect*. What a relief!

My goal for May is three completed wheels and pinions, so I am 1/3 of the way there, with the center wheel and pinion cut. I finished the wheel on Thursday, leaving my normal Sunday SIN block open, so tonight I made the wheel blanks for the 8-day and third wheel, and attempted to cut my first "real" pinion.

I have realized that this project is starting to fall into a pattern: every time I try something new, I discover a new way to screw up, and learn a valuable lesson.

This Week's Lesson: on tiny parts, tiny errors are huge.

The picture at left shows my first attempt at a "real" pinion (I apologize for the poor quality of the photo, but it's the best I could get of this tiny piece). In contrast to the center pinion, which was actually just a small wheel, this is a real pinion-- only 7 leaves, cut from brass rod.

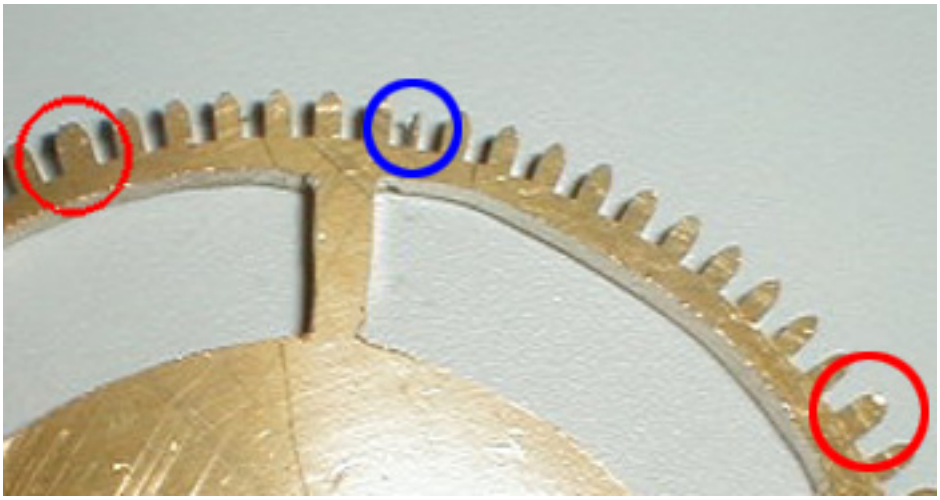
There are two problems I encountered making these. The first is a problem caused by my poor setup. If you look closely at the picture, you will note that all of the teeth slant slightly to the left. This is called "wolf teeth", and is caused by improper alignment of the blank when cutting the teeth. In my case the blank was about .05mm too low, undoubtedly caused by some measurement error during setup.

The second error is a possible design error. I need these pinions to fit on both 2mm and 3mm pivots, but looking at the one I made (drilled for a 2mm pivot), I'm not sure that I will have enough brass left if I cut a 3mm hole. If these do end up too thin, I will have to remake my 3mm pivots as 2mm pivots.

April 28 - Adventures in Wheel-Cutting

Busy week this week-- not only did I go up to the city on Thursday for the first SIN get-together (and had a great time-- thanks EZ!), but I also spent a lot of time cutting wheels.

Wheels are one of the things that screams "clock"-- all of the metal bits so far look like, well, metal bits, but a finished wheel looks like something that belongs on a clock. I'm pretty excited about these, and my first attempts last week turned out great, so I spent a little extra time earlier in the week to try and get the barrel wheel cut so that I could show it at the SIN meeting.



Well, I had something to show alright. A perfect example of how *not* to cut a gear! The picture at right shows my screwups-- the two teeth outlined in red are too large. This was caused by the wheel slipping in its holder, which screwed up the alignment. I didn't notice either of these until I got to the last tooth (the one circled in blue). because the other two teeth were too wide, this one ended up too narrow.

So, what we have here is scrap metal. There was about 6 hours work into this part before I spent 2 hours cutting teeth in it, so this one hurt. I have to start again from scratch.

In the end, however, I learned a couple of valuable lessons from this fiasco:

- Be very careful to control vibration while wheel cutting. Vibration was what caused the wheel to slip while I was cutting.
- Cross out the wheel after you cut the teeth. Part of my vibration problems were caused by the fact that so little metal was left for the teeth.
- Use a very slow feed rate with the larger wheels. This also helps control the chatter.

Tonight I took my newfound knowledge and put it to use on the center wheel for the clock (the largest of the wheels). In my three hours I got the blank made and mounted, and 28 of the 84 teeth cut. So far everything is nice and even, but I'm still being extra cautious. Hopefuly I can have it done for next week.

April 21 - A Milestone!

This week held a fairly momentous occasion in my horology career-- I actually cut my first wheel!

As I reported last week, I finally ordered the wheel cutters for the clock. Well, on Saturday a package from England arrived with 4 cutters in it: one for M1.0 wheels, one for 7 leaf M1.0 pinions, one for ratchets, and one for recoil escape wheels. I could hardly wait for SIN time to try them out!

The photo at left shows my first attempt at wheel cutting-- the center pinion. This wheel was chosen for several reasons:

- It was the smallest (less wasted brass if I screwed it up)

- It had the fewest number of teeth.
- The spacing was easy to calculate (20 teeth-- 18 degrees per tooth).

I spent most of my SIN time for the week making this one part, since I was being extra careful. I also was learning how to use my dividing head and milling attachment, which slowed me down.

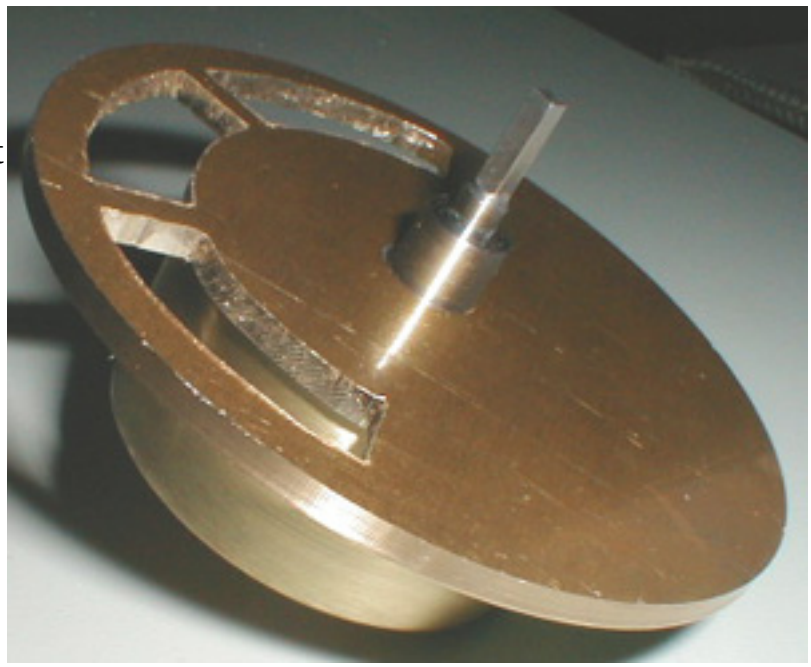
The good news, however, is that it came out perfect on the first attempt! Still, it was more than a little nerve-wracking. The real test comes next week, where I cut the teeth in the barrel wheel (which I just finished crossing out). I'd sure hate to screw up *that* after all the work I've put into it.

April 14 - The Barrel

Well, I lost two weekend of SIN time (college tour with my son), so this is my first update in 3 weeks. All in all, I'm still making progress, though, despite losing the time. I managed to sneak in a couple of half-hour blocks late in the evenings, which really helped. Since there's nothing major planned for a while now, I should be back to my 3 hours on Sunday and whatever I can grab during the week.

The photo at right shows my progress since last report. As you can see, the barrel and barrel cover (left) are completed, and am halfway done with crossing out (horology-speak for cutting the spokes) the barrel wheel. The barrel is made from a piece of 2-inch diameter brass tube, which has a tapered lip machined into the edge. Into the lip fits the barrel cover, which is a press fit brass disc. If you look closely at the picture, you can see a small notch in the cover that allows you to slip a screwdriver in to snap out the cover.

The wheel is recessed to hold the barrel, which will eventually be soldered in place. This was actually a firly tricky bit of machining, but it came out quite well-- the fit is nice and snug.



The picture at right shows the pieces all fit together. I still need to cut the remaining spokes and polish the cut edges, but it's starting to look like something that belongs in a clock!

My other big accomplishment for the week was that I finally ordered the wheel cutters. I had to order them from the manufacturer in England (so they are liable to take a bit of time getting here), but when they arrive I should be ready to actually cut gears!

March 23 - The Barrel Pivot

Since my last report, I finished the barrel pivot (which really was pretty easy), and am ready to begin work on the barrel iteself. The barrel is a big brass tube that holds the mainspring, and one of the more interesting parts of the clock.

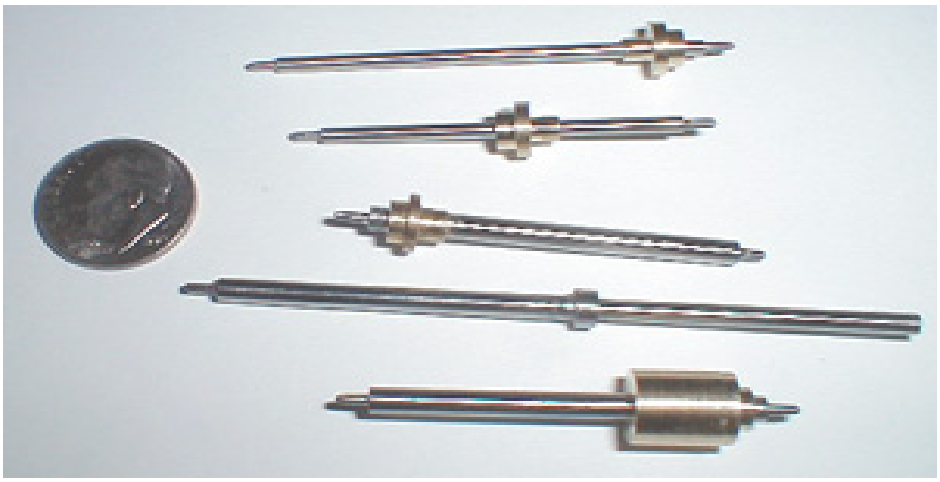
The way the barrel works is pretty cool. The barrel pivot is the only one not attached to its gear-- it has a hook that attaches to the mainspring, and the other end of the mainspring is attached to the barrel tube. The pivot also has a ratchet on it that only allows it to turn one way. The ratchet allows you to turn the pivot to supply tension to the mainspring, while preventing the pivot from being able to release this tension. This means that the only way to release the tension is for the barrel to turn, thus providing power to the clock!

The picture at right shows the completed barrel pivot. You can see the hook to engage the mainspring (a nasty bit of file work there!), and if you look closely you can see that the shaft has been squared off to allow a key to be used to wind the clock. It still needs to be polished, but it's done otherwise.

March 17 - Making Pivots

I didn't post an update last week, since I overran my SIN time with making stuff, and didn't have

the time to do the web work. Since I've been doing basically the same thing for two weeks, this report will cover both.



The picture at right shows my last two weeks progress. I have spent this time making some of the most demanding pieces of the clock-- the wheel pivots. These are slender rods of steel that the clock wheels will be mounted to. They are cut to very precise dimensions (within .01mm) and polished to a high shine to help reduce friction. To give you an idea of scale, that's a dime in the picture!

These pivots range in length from 46 mm to 72 mm, and range in diameter from 2 to 3 mm. Each pivot will have a brass collet soldered to it to hold the wheel-- most of the ones in the picture have the collet attached, but I still have a few to make.

At this point, I still have a little bit more work to do to meet my March goal (completing the pivots). I still have to make a couple more wheel collets, as well as the largest pivot of all, the barrel pivot. After working on all of these skinny (and thus easy to break!) pieces, working on something as large as the barrel pivot will be a piece of cake.

March 3 - I'm glad *that's* over...

Wow-- February was hard!

Not only did I not make as much progress as I set out to (which is OK, since I set a pretty aggressive goal), but I really started to get frustrated with the project. I hit some fairly major snafus, made a couple of serious mistakes, and ended up spending a lot of my SIN time not accomplishing much.

The good news is that I am making progress again, so I can thank SIN for not letting me give up in frustration. I actually learned a lot from my screwups this month, the primary lesson being that I still have a long way to go with my metalworking skills.

This week I actually completed a part that has been giving me fits: the center pivot. All in all it took me about 8 tries and well over 12 hours to make this piece, but it's now done and within tolerances! Unless I totally screw up the polishing and hardening, I should be good to go.

Looking back on the month, however, I find that I actually accomplished quite a bit. My two goals for March 1 were to get all of the measured drawings done and on the web, and the plates and pedestals made. As of this morning, I have about 2/3 of my measured drawings done and on the web, and a beautiful set of plates and pedestals. The rest of the measured drawings can wait for a little while, since I have plenty to keep me busy for the coming month.

My goals for April 1st are to complete all of the pivots and wheel collets for the clock, and order

the remaining tools and materials for wheel cutting.

February 24 - A Slow two weeks

This is my first update in two weeks, since I was out of town for 4 days last weekend. Since I was on the road and away from my tools I was not able to get my 3 hour block on Sunday afternoon, but I tried to make up for it by SINning a few times during the week before.

As it stands right now, I've got about 2/3 of my measured drawings finished (but not in publishable form yet), which is not so bad considering I lost a week. I really don't think I'll be able to hit the second half of my February goal of getting them all done and on the web, but it'll be close.

For my metalwork this week, I attacked the most complicated bit of turning-- the center pivot. This is a very long and slender piece that needs to be made from a much thicker rod. My first few attempts at it were dismal failures, which was a little disheartening, but I've figured out a couple of tricks that should help with future attempts.

The failures in making the center pivot this week had another adverse affect. After ruining a piece that had an hour's work into it (for the 3rd or fourth time) I really got frustrated with the project, and thought about putting it aside and doing something else for a while. With the SIN team counting on me, though, I put those thoughts out of my mind and plowed ahead.

It feels great to know that I *will* finish this clock, and I don't think I could do it without SIN pushing me.

February 9 - Making Progress Again

Well, this week was spent mostly recovering from last week's series of debacles. With a bit of concerted effort I was able to get to where I was hoping to be a week ago. Bummer.

My order of extra saw blades and barette files came, so I was able to finish cutting out the front and back plates. I ended up breaking a bunch more blades, but my technique got pretty good by the end.

I learned some important skills in doing all of the piercing work for the plates, which I hope will help when the time comes to pierce the wheels. By the time I made the last cutout on the back plate, I was able to cut almost exactly to the line, which really cut down on the filing needed to get the part to where it was supposed to be.

When all was said and done, though, it felt pretty good to mount the pedestals to the plates and see what the whole thing would look like. As you can see from the picture at right, everything lined up nicely and it all looks pretty good. Once the blue layout dye gets washed off and everything gets polished it'll look even better...

The bad news is that I am about a week behind my aggressive goal for the month. Next week I am out of town for a 4-day weekend, so I am going to try to get some extra SIN time during the evenings this week. Even with the extra SINning, I don't know if I'll be able to make up for the lost time.

February 2 - My First Setbacks

I guess I was fairly lucky up until now, since I had no *major* screwups. This week just about everything went wrong...

I started on the clock plates, and made a disturbing discovery almost immediately: My hacksaw was unable to cut deep enough to cut out the plate profile. My high-tension hacksaw has only two blade positions, and neither would work. Luckily I had an old marquetry fretsaw that could take jeweler's saw blades. The cutting would be a *lot* slower, but at least I had plenty of throat depth.

As I was finishing the cuts with the fretsaw I made disturbing discovery number two: jeweler's saw blades are much easier to break than normal fretsaw blades. I managed to go through my entire stock of three dozen blades, and I still am not finished with the piercing work. A valuable lesson, unfortunately learned the hard way...

Since I was not going to be able to finish the sawing, I decided to drill the alignment holes for the plates. These are the holes used to line up the plates for drilling the pivot holes, so these must be done extremely accurately. I did a pretty nice job on the holes-- the top hole wandered very slightly off-center, but the two plates line up fine. It shouldn't be an issue at all.

After drilling the holes and making the alignment pins (used to hold the plates together when drilling), I made disturbing discovery number three: the holes were larger than my largest broach. Most parts in clock work are custom fit-- the holes are drilled slightly undersized and reamed to fit with a special tool called a broach. Unfortunately my alignment holes are 5 mm (to fit the pedestals), and my largest broach is a hair over 4.5 mm.

Distrubing discovery number four came when I was filing the edges of the only cutout I was able to complete before I ran out of blades. As I was working the edges down to the layout lines, I found that the 45 degree corners are too tight to fit even my smallest needle files. After consulting with one of my "dream team" I found out that there is special kind of file called a "barette" files which is used for this situaton. These are special files that you won't find in a typical hardware store-- they have to be special-ordered (and so are kind of expensive).

So, I have another order in to S. Larose (a clock parts distributor)-- a couple of *gross* of jeweler's saw blades, a set of extra-large broaches, and a pair of barette files (one mill, one smooth). Until these get here there's not much I can do, so this week will probably be spent mostly working on the CAD drawings.

Lets hope next week goes a little better...

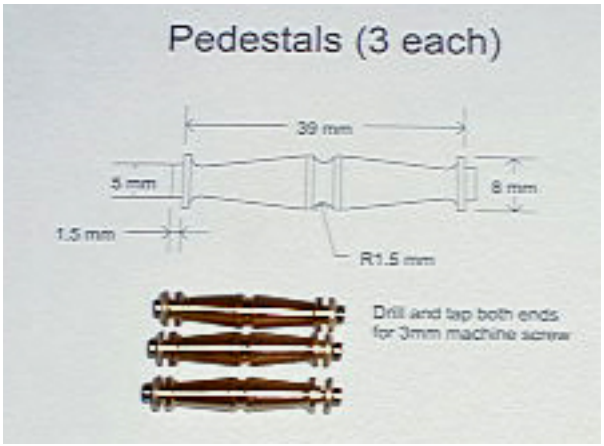
January 27 - The First Parts

I was on vacation and jury duty this week, so I got to devote a little extra time to the project. I managed to finish the design pages, and move the whole shooting match to the web. I still haven't linked it to my oldtools pages, since I need to check out the links and make sure everything works and looks good on different browsers.

I found a local source for the oddball metric screws and taps I needed, so this week I made a field trip to Elmhurst (about an hour drive for me) and picked up a bunch of teensy metric cheese-head screws, and a couple of matching taps/drills. The place I got them from (McMaster-Carr) is pretty

amazing-- they have all kinds of oddball industrial supplies. I'm sure I will be making a lot more use of them as the project moves on, since they are only a couple of miles from my office in Oak Brook.

I also spent some time on making the measured drawings for the individual parts. I finished the drawings for the front and back plates and the pedestals that hold them. These are still in CAD format, so I will need to do a bit more work to get them onto the web.



The most exciting breakthrough this week, however, was that I actually made the first part of the clock! I turned the three pedestals (a fairly complex bit of lathe work), and what's even more impressive, I managed to get them within .01 millimeter of the size I was shooting for. I also turned a couple of matching brass washers for the pedestals, and drilled and tapped the ends to take some of my new cheese-head screws. This makes these the first *completed* piece of the clock! Woohoo!

Next week I will be starting on the clock plates, which are the largest parts of the clock, and quite honestly somewhat scary to make. I have them laid out right now, but have not yet worked up the nerve to actually try to start cutting them...

January 20 - Almost ready to go

What a busy week! I not only managed to get my workspace up to snuff, but I was also able to complete the initial design for the clock.

The cabinet for the work area was a piece of cake. I already had most of the hardware (drawer slides, hinges, pulls) lying around, so I just got a couple of sheets of construction ply and whipped together a 6-drawer cabinet with enough space to store my lathe and grinder. I toyed with the idea of running a new circuit to the bench, but decided instead to just use a plug strip run to an outlet in my woodworking shop. It's not quite as nice, but it took a lot less time...

The bench and vice are now rock solid, so I can saw and file much more accurately. It's really amazing what a difference a good workspace makes on the quality of your work.

Most excitingly, however, I finally finished the basic plans for the clock! I hit a couple of other minor snafus, but in general the final design is quite close to my third design.

Also this week, some of my "specialty" clockmaking tools arrived. I got a jewelers saw (a coping saw for metal) with a couple of dozen blades, some cutting and smoothing reamers (used to taper holes), and a staking anvil for riveting wheels. I am still looking for a good source for the "cheese-head" screws used in clocks, and a couple of tiny metric taps.

Next week I will create the web page showing the design, and start on measured drawings for the individual components.

January 13 - Organizing

This week I spend most of my SIN time working on improving my machining skills and setting up my workspace.

The parts I am most nervous about making are the pivots, so I figured that's a good place to start. These are going to be some of the first really high-tolerance parts I make, and they are one of the few parts that will be made of steel (which is harder to machine than brass).

The good news is that I was able to turn passable pivots from some drill rod I had laying around. The bad news is that I am having a heck of a time getting them to come out the proper length. My technique really stinks right now, and I'm lucky if I can get things made to within a half-millimeter of the right size (eventually these will need to be accurate to within a couple of hundredths of a millimeter). I can see some improvement in the few I've made, though, so there's a light at the end of the tunnel.

My other big project this week was to set up a metalworking workspace. I have been using my woodworking bench, but this will not be a good long-term solution for me (metal chips can stain wood).

We happened to have an old workbench that has been sitting unused for a year or more (my son used to use it for a hobby he no longer pursues), so I co-opted it for my new metalworking bench. This bench turned out to be much too flimsy for my work, so I decided to stiffen it up by building some cabinets to fit under it. This will take a couple of days of my SIN time to complete, but once it is done I will have a nice solid work area, and some drawers and cabinets to store my metalworking tools.

Didn't do much on the design or web page this week, but I'm still on track for the end of the month.

January 6 - And awaaaay we go!

Since this is the first entry, I will begin with a synopsis of where I am so far.

I saw the SIN posting in the Trib in November, and decided that I would go for it and finally try to build a clock. I had been seriously reading horology books for a year or so, and half-heartedly assembling a set of clockmakers tools, so I knew where I needed to start.

I have very little in the way of metalworking tools, so that was one of my top priorities. As I said, I had been looking for antique clockmaking tools for a while, and had some of the basics, but it turns out that clockmaking tools are significantly more scarce than watchmaking tools-- a lot of what I had was going to be fine for watchmaking, but was not large enough for clock work. I needed some tools.

After talking to several horologists about my plans, they convinced me that while it was certainly possible to build a clock using antique tools (several of them did this very thing), it was probably not a good place to start. Everyone I talked to thought it would be better to learn on high-quality

modern equipment, and move to the antique tools as my skills improved. Much as I love my antiques, I had to admit they were right.

So, step one-- find a metalworking lathe and mill suitable for clockmaking. After a bunch of investigation, I purchased a small lathe/mill combo, with the necessary attachments for wheel and pinion cutting.

While I was playing with my new lathe and brushing up on my machining skills, I encoutered another minor difficulty. Clockworks are always made using metric measurements, and all of my accurate measuring equipment was in imperial units. OK-- so I need a metric vernier caliper, micrometer, and dial indicator. I found a nice antique 15mm micrometer on ebay, and purchased a cheapie dial caliper and indicator from an importer to hold me over until I can find the equivalent antique models at a good price.

I have been using most of my SIN time familiarizing myself with my new tools, and reviving my long-dormant metalworking skills. I did a fair bit of machine shop work in college (I was a metallurgical engineer), but that was a *long* time ago. My machining skills were rusty, to say the least...

In addition to my adventures in metalworking, I also started on the design for my clock. I created an Excel spreadsheet to figure out my gear train calculations, and after a few hours of experimentation I came up with what I thought was a workable design. This stuff isn't so difficult after all, I remember thinking...

Well, it took about two hours with my CAD program to figure out that what I designed was totally infeasible. Turns out I had discovered a fundamental law of gear train design that I never encountered in any of my textbooks-- the radius of a gear plus the radius of the pinion it meshes with must be *greater* than the radius of the next wheel. Now that I've figured it out it's glaringly obvious (which is probably why the books never mentioned it), but I completely missed this in my original design.

As an engineer I am used to throwing away designs, so this setback didn't phase me in the least. I set to work with my newfound knowledge, and after a day or two of thinking I came up with another design. This one took into account the size of the driving gears, so it went much better. It took me almost four hours of CAD work to figure out that this one wouldn't work either...

This time it wasn't a fundamental law that I missed, it was just an oversimplification of the design. I had laid out all of my pivots in a nice straight line, and it turned out that the distance from my center pivot to the third pivot was *exactly* the same as the distance from my center pivot to my minute wheel pivot. In other words, I ended up with two things that needed to be in the same place-- on to my third design.

My third design offset the 8-day wheel and minute wheel. This had several desirable effects-- it eliminated the problem with design two, and also shortened the overall height of the movement. The design also had kind of a neat "Arts and Crafts" style shape to it, which I really liked. This one managed to make it almost all the way through the CAD process before I encountered its fatal flaw-- the movement was now too short to fit the necessary pendulum.

Fortunately, this problem was pretty easy to address. I simply increased the module of my gears

from 0.8 to 1.0 to accomodate the pendulum. The rest of the design was unchanged, it was just a little larger. I have been working with this design for almost a week now, and it looks like this one one might be the one. I've still got a lot of work to do on the design, so we'll see.

So what's next? The first SIN newsletter came out and asked us all to make a plan for where we want to be after January. My goal is to finalize my design so that I could start doing detailed blueprints for the various parts, and to create a series of web pages to document the project.

Obviously, I am working on it... ;-)

Design of the SIN Clock

The SIN clock is a fairly typical skeleton clock, using a traditional spring-driven movement. In order to keep it simple (it is my first clock after all), it uses a recoil escapement and fairly large wheels (module 1.0).

The Gear Train

Name	Wheel Teeth	Wheel OD (mm)	Pinion Teeth	Pinion OD (mm)
Barrel	84	86.7	n/a	n/a
8-Day	80	82.7	7	8.48
Center	84	86.7	7	8.48
Third	78	80.7	7	8.48
Escape	36	42.4 *	7	8.48

* - *Assuming a 5E Cutter, 8mm radius*

This arrangment gives a train count of approximately 9627, or 160 beats per minute. This requires a theoretical pendulum lenth of 139 mm, so my first guess at the actual pendulum lenth will be approximately 220 mm (true length will be determined by experimentation later).

The 48:1 gear ratio for the power train will allow the movement to run for approximately 10 days on a single winding (5 turns of the mainspring).

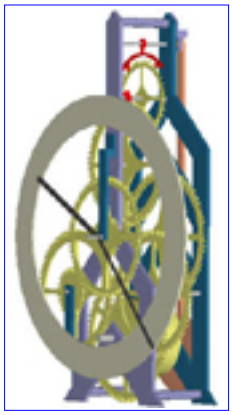
The Motion Train

Name	Teeth	OD (mm)
Cannon Pinion	25	27.7
Hour Wheel	75	77.7
Hour Pinion	20	22.7
Minute Wheel	80	82.7

This arrangement uses a combination of 3:1 and 4:1 gear ratios to make a 12:1 overall ratio. In order to use the same gear cutter as used on the rest of the clock, all wheels have at least 20 teeth.

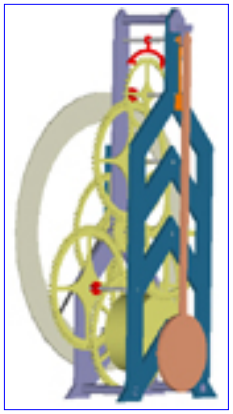
The Clock Itself

I created a series of 3-D CAD drawings to validate the design. The pictures below show various views of these drawings. Click on any picture to show a larger version.



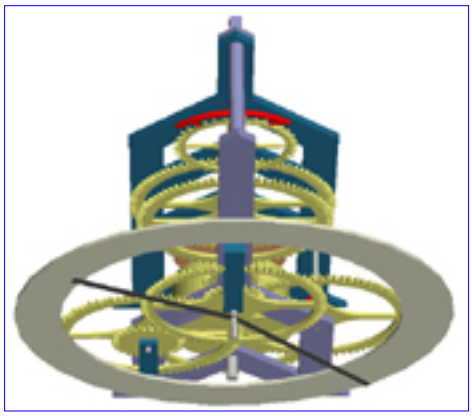
This shows an oblique view of the front of the clock. The chapter ring (grey) will be engraved with numbers one through twelve.

The plates and pedestals are clearly shown (grey-blue), while the cocks holding the movement train are visible in darker blue.

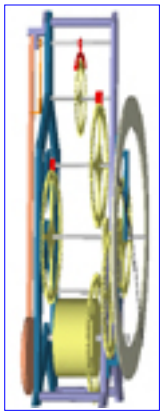


Here is a similar view from the back of the clock. The pendulum and back cock are clearly visible, as is the pendulum crutch (shown in orange).

The "Mission-inspired" shape of the plates is clearly shown in this view. Note that the shape of the front and back plates are slightly different.



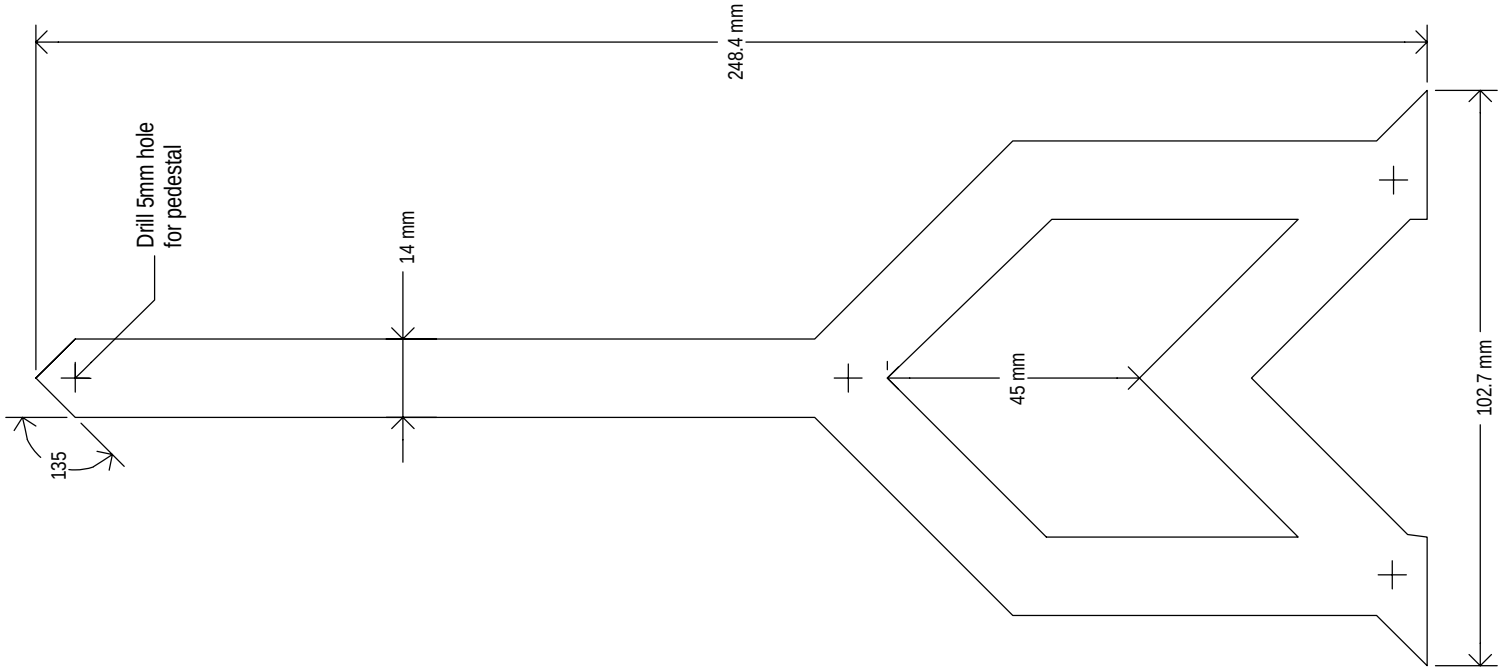
Here is the clock shown from above. You can see some details of the going and motion trains, as well as the escapement.

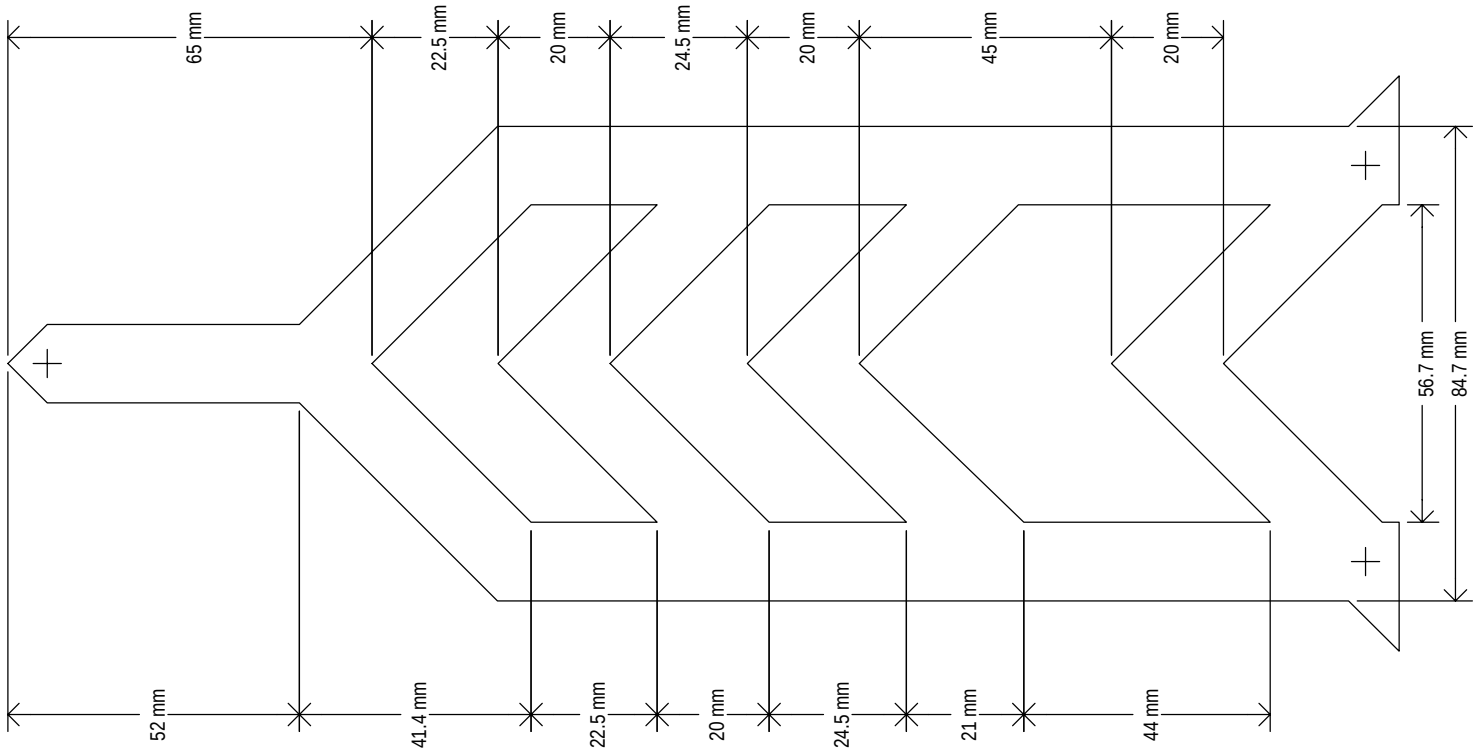


Here you can see the going and power trains in all their glory. Wheels are in gold (obviously), and the pinions and the escapement anchor are in red.

You can also clearly see the barrel at the bottom of the picture.

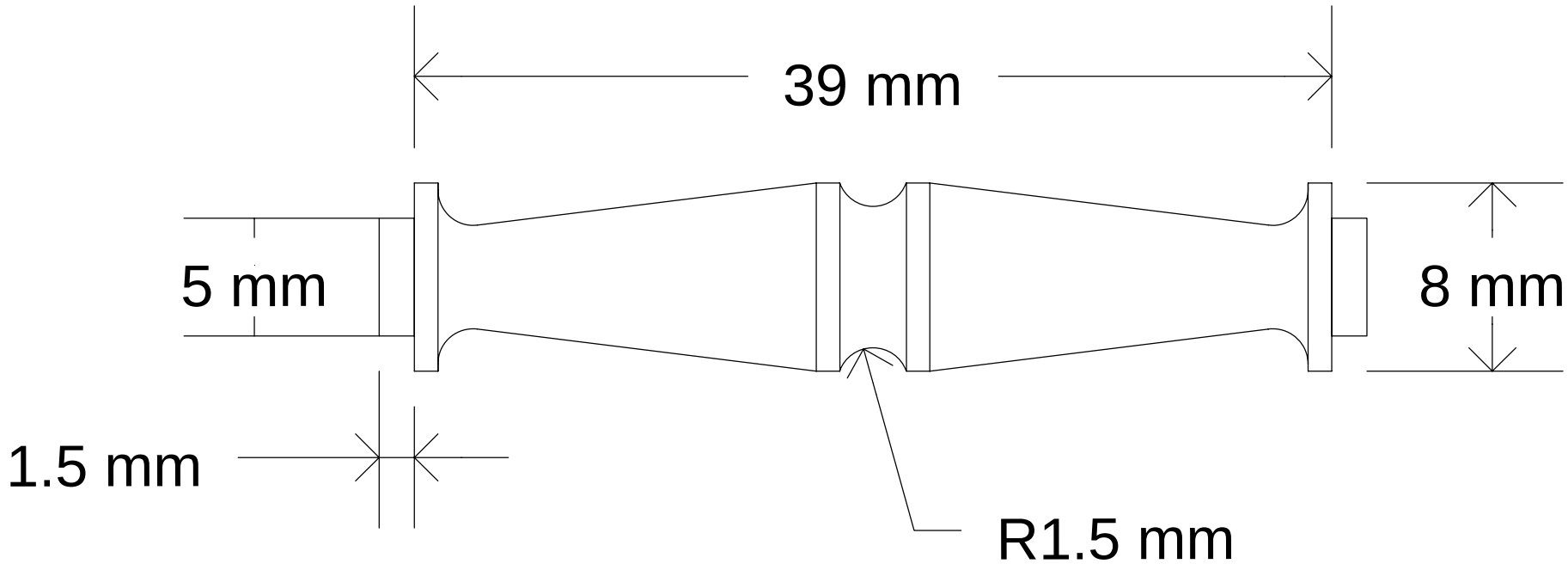
Front Plate (3mm brass)





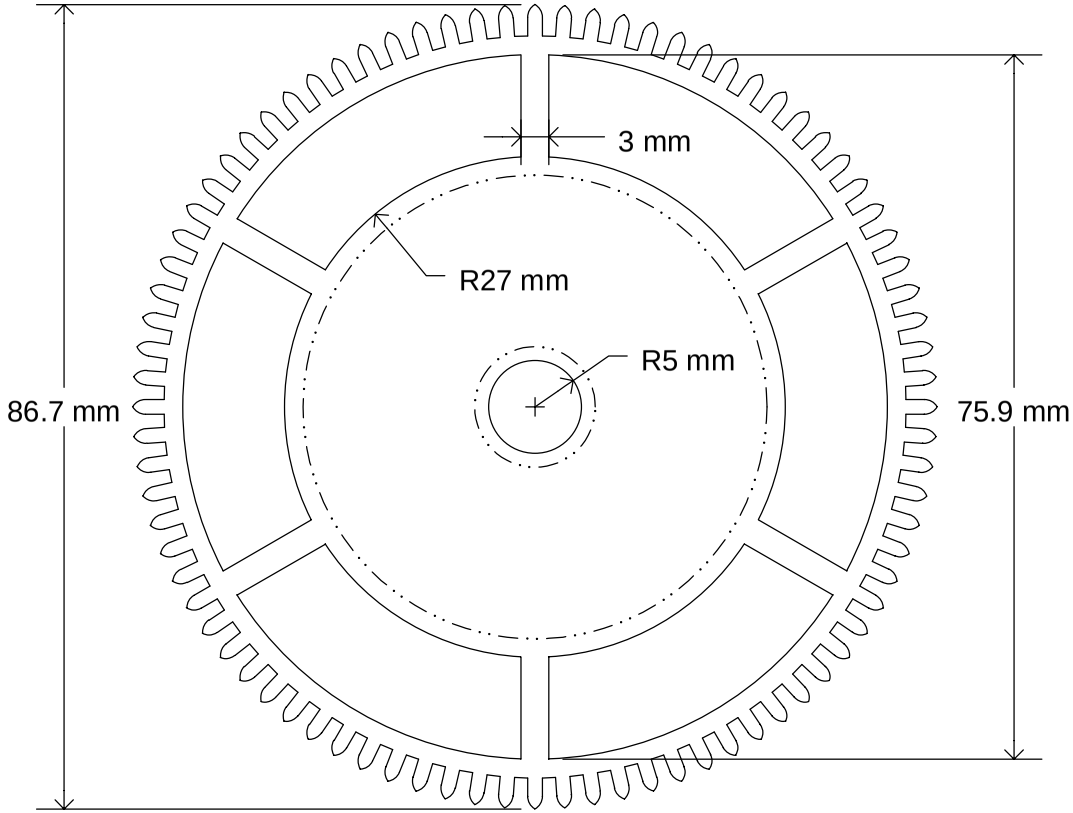
Back Plate (3mm brass)

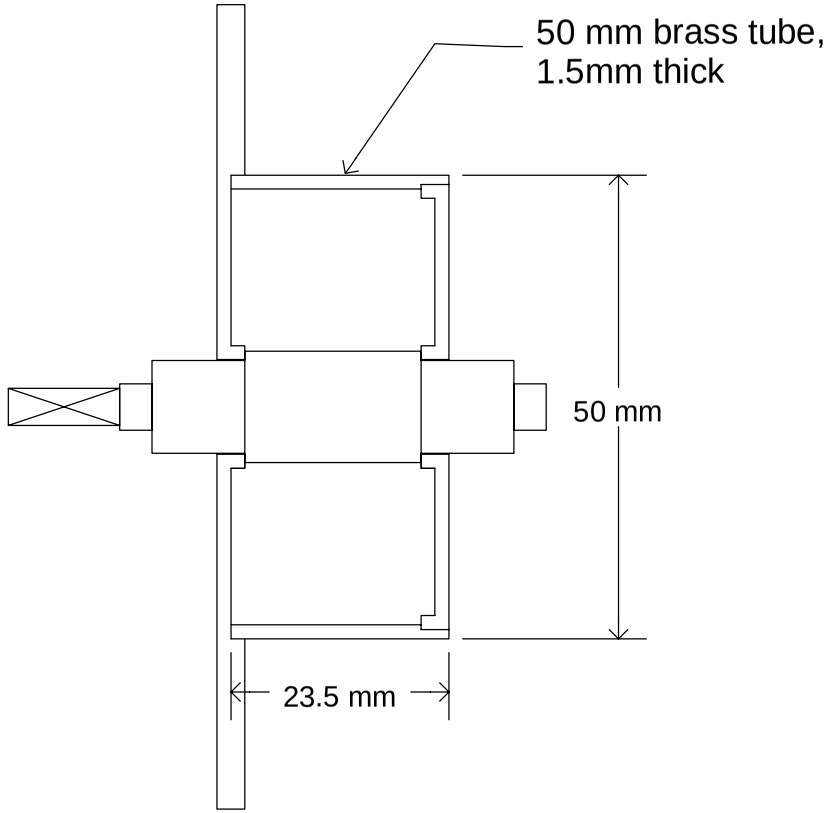
Pedestals (3 each)



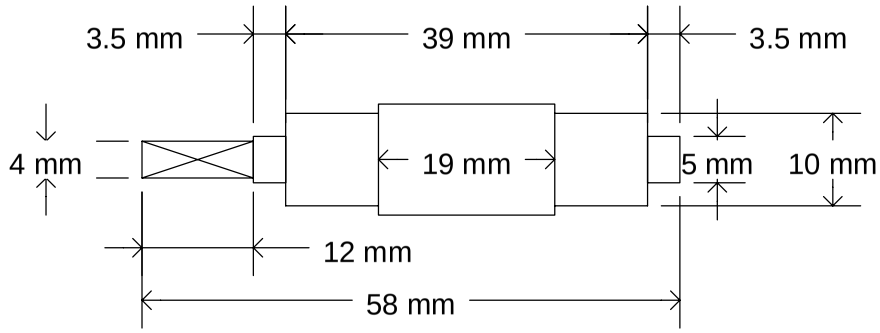
Drill and tap both ends
for 3mm machine screw

Barrel (3 mm brass)

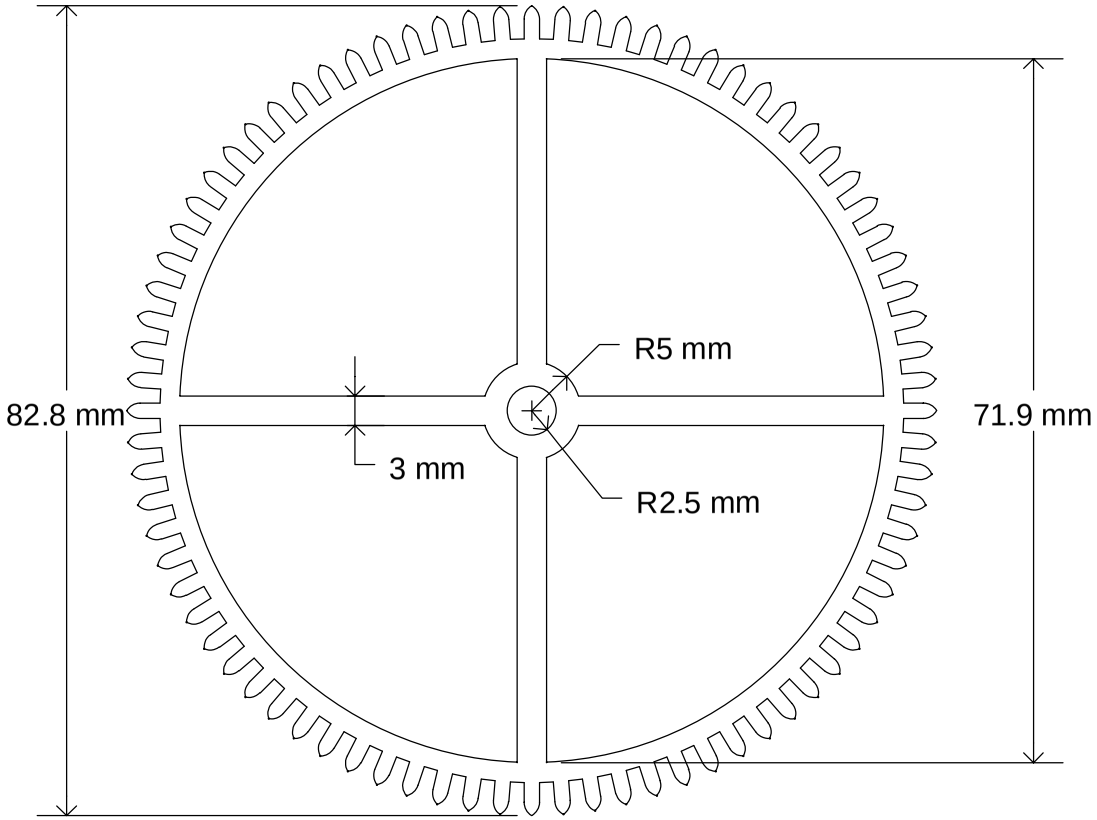




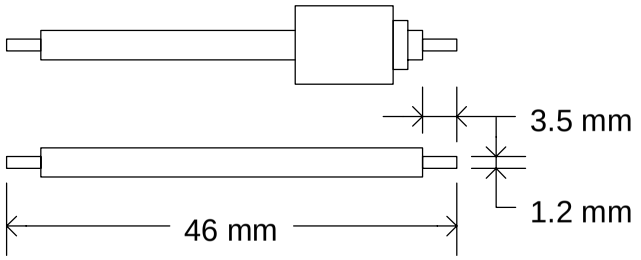
Barrel Pivot (12 mm drill rod)



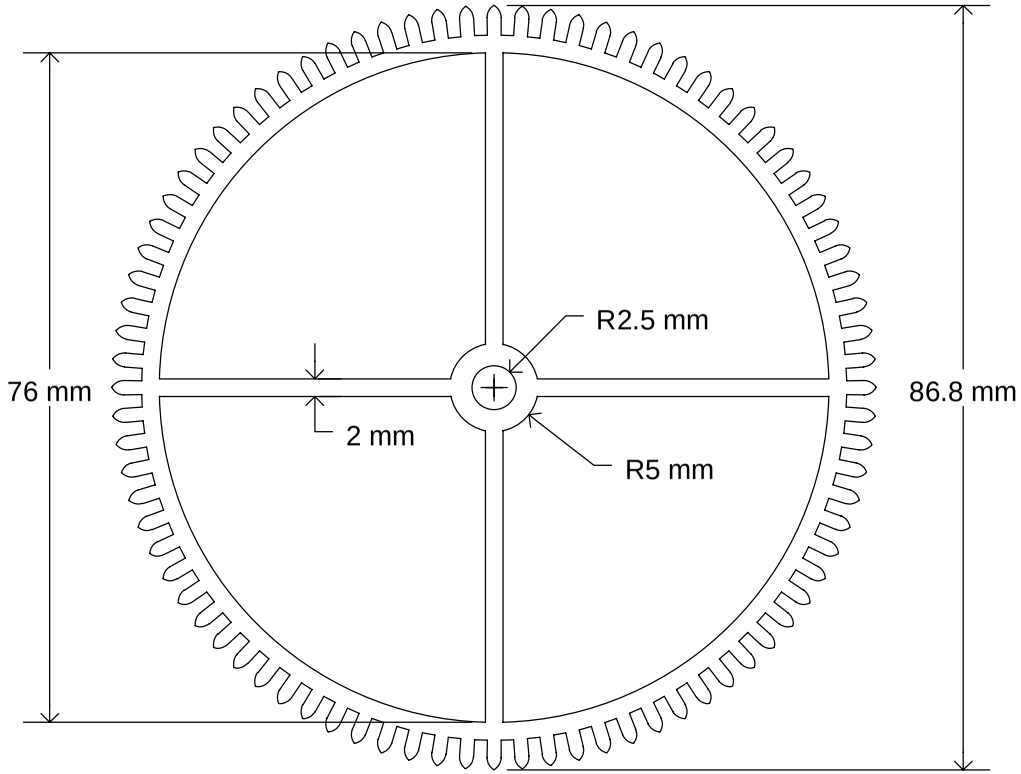
8-Day Wheel (1.5 mm brass)



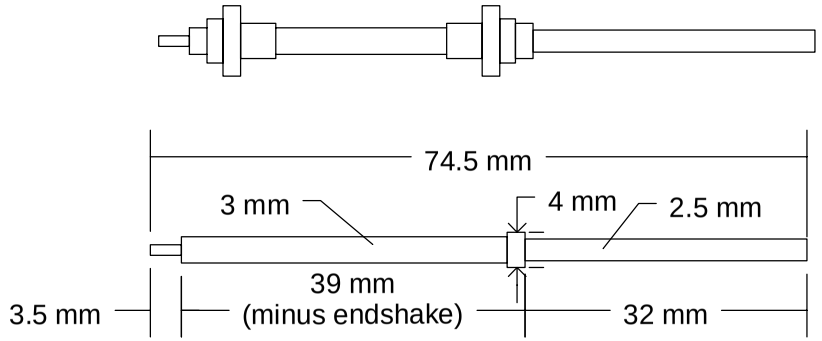
8-Day Pivot (3 mm drill rod)



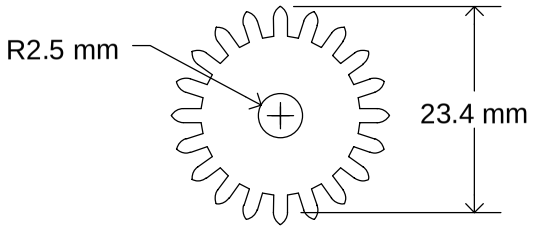
Center Wheel (1.5 mm brass)



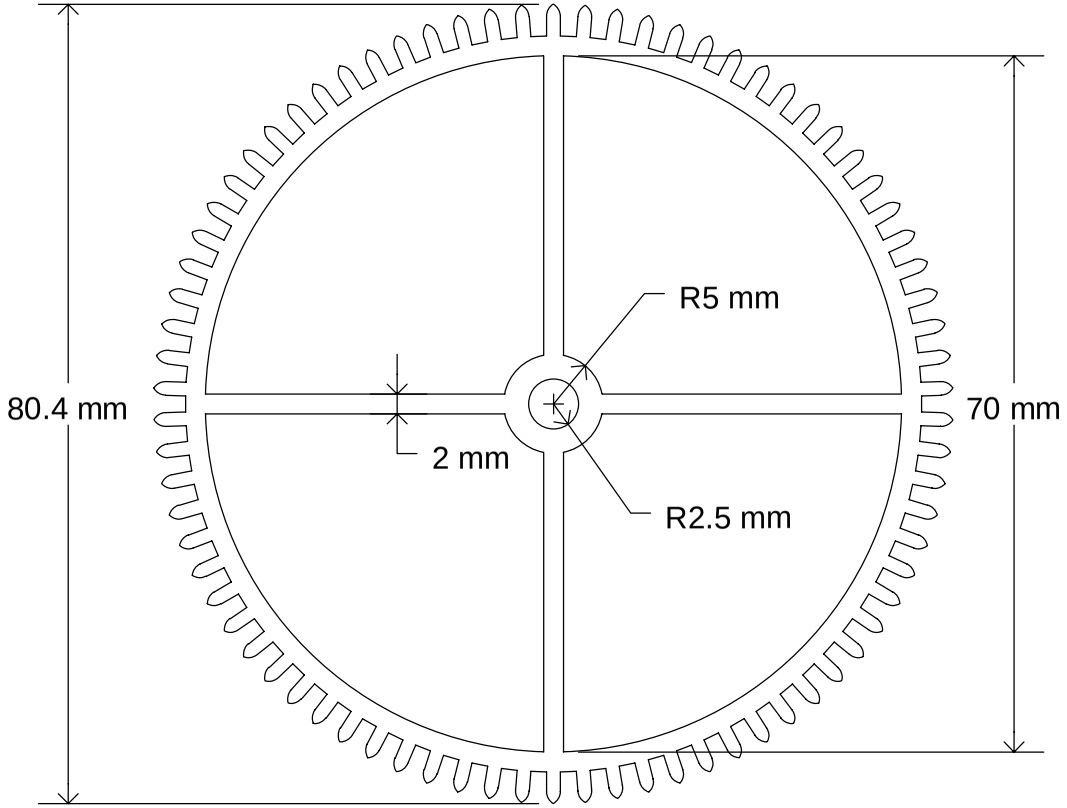
Center Pivot (4 mm drill rod)



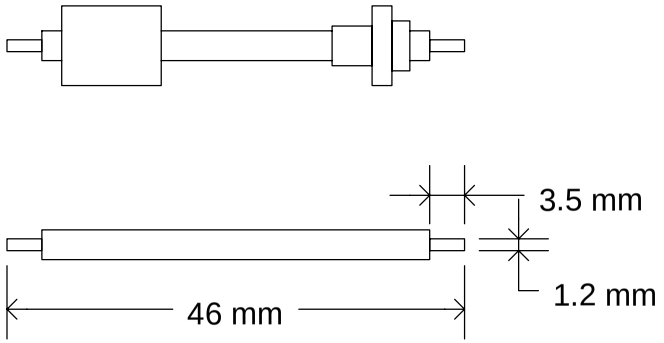
Center Pinion (1.5 mm brass)



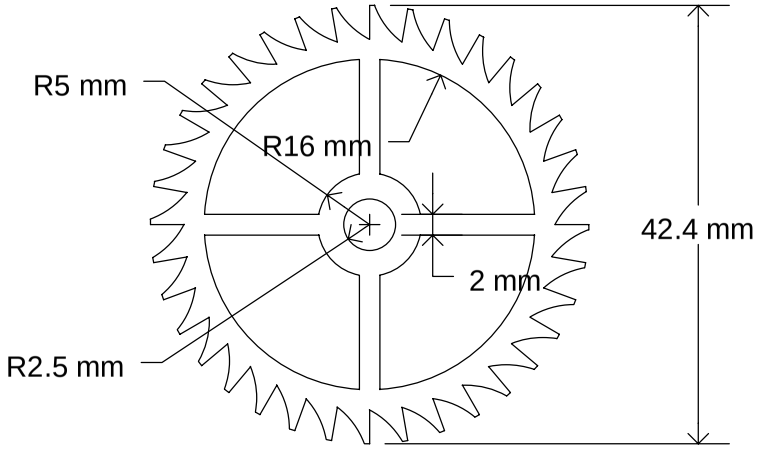
Third Wheel (1.5 mm brass)



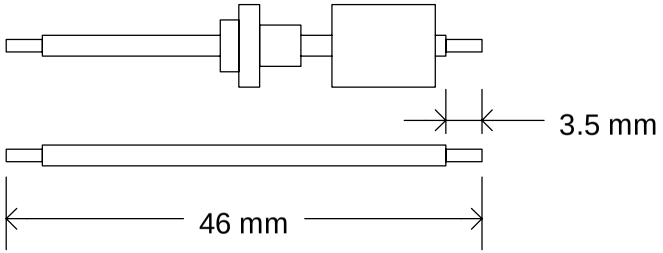
Third Pivot (3 mm drill rod)



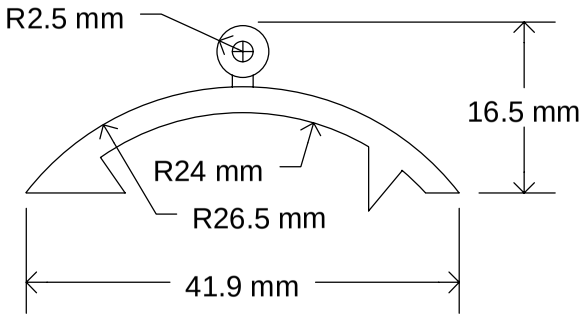
Escape Wheel (1.5 mm brass)



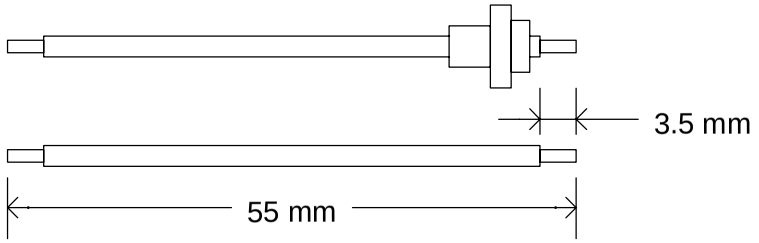
Escape Pivot (2 mm drill rod)



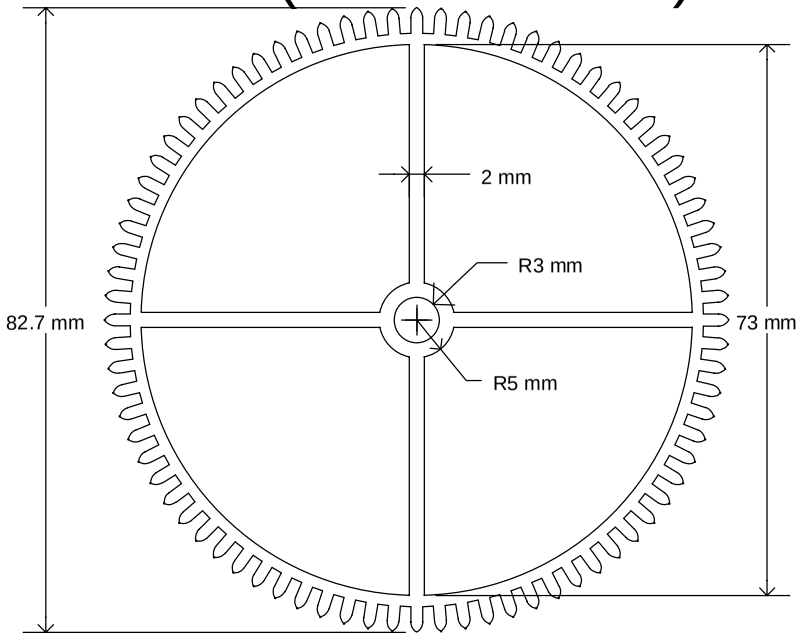
Pallets (3 mm steel)

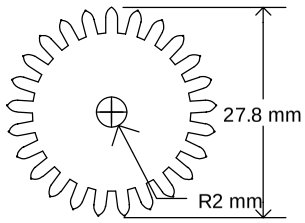


Pallet Pivot (2 mm drill rod)



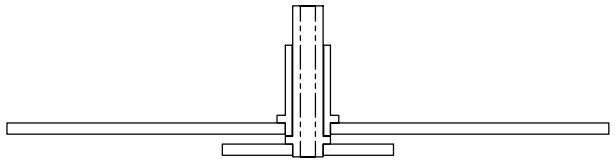
Cannon Pinion/Hour Wheel (1.5 mm brass)

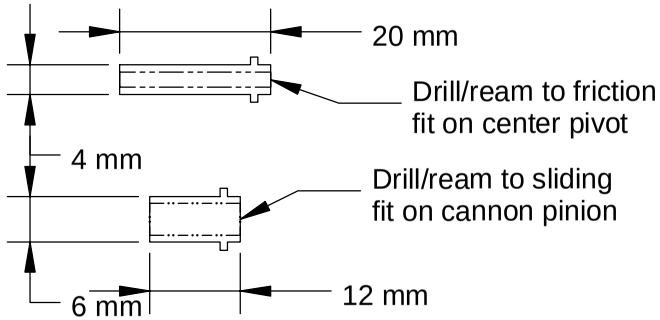




Wheel: 80 Teeth
Pinion: 25 Teeth

Pivot Detail





Hour Pinion/Minute Wheel (1.5 mm brass)